1974

The Naval Communications Processing and Routing System: a model for management

Barker, Michael Don; Lawrence, William Robert

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/17143

THE NAVAL COMMUNICATIONS PROCESSING AND ROUTING SYSTEM: A MODEL FOR MANAGEMENT

Michael Don Barker

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE NAVAL COMMUNICATIONS PROCESSING
AND ROUTING SYSTEM:
A MODEL FOR MANAGEMENT

by

Michael Don Barker

William Robert Lawrence

September 1974

Co-Thesis Advisor: N.F. Schneidewind

Co-Thesis Advisor: Sam H. Parry

Approved for public release; distribution unlimited.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Naval Communications Processing and Routing System: A Model for Management		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; September 1974
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Michael Don Barker; William Robert Lawrence		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE September 1974
		13. NUMBER OF PAGES 124
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Naval Communications, NAVCOMPARS, LDMX, Naval Communications Processing and Routing System, Local Digital Message Exchange, Automated Communications, Management Model, Simulation Model, GPSS Model, General Purpose Simulation System.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis represents the results of a study of the U. S. Naval Processing and Routing System (NAVCOMPARS). The system's development from preconception to present is described herein as

DD FORM 1473, 1 JAN 73 (Page 1) EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Block 20.

well as a description of its hardware and software components. Additionally, the Local Digital Message Exchange (LDMX), is likewise described.

The purpose of this thesis is to identify bottlenecks in message flow through NAVCOMPARS. In this attempt, the system was simulated in a functional manner by computer and various input distributions were applied. By so doing, the factors, events and situations contributing to bottlenecks in message processing are identified as fully as possible within the constraints of time and information availability.

The Naval Communications Processing
and Routing System:
A Model for Management

by

Michael Don Barker
Lieutenant Commander, United States Navy
B.S./B.A., University of Tulsa, 1965

William Robert Lawrence
Lieutenant Commander, United States Navy
B.S., U. S. Merchant Marine Academy, 1964

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 1974

ABSTRACT

This thesis represents the results of a study of the U. S. Naval Processing and Routing System (NAVCOMPARS). The system's development from preconception to present is described herein as well as a description of its hardware and software components. Additionally, the Local Digital Message Exchange (LDMX), is likewise described.

The purpose of this thesis is to identify bottlenecks in message flow through NAVCOMPARS. In this attempt, the system was simulated in a functional manner by computer and various input distributions were applied. By so doing, the factors, events and situations contributing to bottlenecks in message processing are identified as fully as possible within the constraints of time and information availability.

TABLE OF CONTENTS

LIST OF FIGURES

TABLE OF ABBREVIATIONS

ACC	AUTODIN Communication Controller.
ACS	AUTODIN Control Subsystem.
ADPE	Automatic Data Processing Equipment.
APS	AUTODIN Processing Subsystem.
AUTODIN	Automatic Digital Network, a Defense Communications Agency fully supported digital communications system.
CCM	Multichannel Communications Controller.
CCS	Communications Control Subsystem.
CIS	Communications Interface Subsystem.
COBOL	Common Business Oriented Language; a symbolic programming language designed primarily for business data processing.
CPU	Central Processing Unit. The computer component that includes the primary foreground programs to perform message processing.
DD173	Standard message form suitable for input through and optical character reader.
DPS	Distribution Processing Subsystem.
DXC	Data Exchange Controller. A direct AUTODIN interface.

ECC	Electronic Courier Circuit.
ECS	Executive Control Subsystem.
FIFO	First-in/First Out.
FORTRAN	FORmula TRANslator. A computer language designed primarily to express problems involving numerical computation.
FS	Fallback Subsystem.
GMT	Greenwich Mean Time.
GPSS	General Purpose Simulation System.
K	Alphabetic term used to equal 1,000.
LDMX	Local Message Digital Exchange; directly connected to AUTODIN with limited capability to provide on-base electrical distribution through appropriate interface devices.
lpm	Lines Per Minute.
MIS	Management Information System.
MPDS	Message Processing and Distribution System.
MPS	Message Processing Subsystem.
MSU	Message Switching Unit (AUTODIN), Mass Storage Unit (ADPE).
MTU	Magnetic Tape Unit.
MUX	Multichannel.

NAVCOMPARS	Naval Communications Processing and Routing System; a system to obtain fully automated Naval Communications System which satifies requirements for overall speed, reliability and systems compatibility.
OCR	Optical Character Reader.
OTC	Over-the-counter service.
PCS	Program Control Subsystem.
PRI	Primary.
PSN	Processing Sequence Number.
RCS	Receive Control Subsystem.
RI	Routing Indicator. A group of letters assigned to a message to indicate the geographical location of a situation to facilitate the routing of traffic over communications relay networks.
SEC	Secondary.
SPS	Support Program Subsystem.
TCS	Transmission Control Substystem.
TOD	Time of delivery.
TOR	Time of receipt.
TPS	Transmission Processing Subsystem.
TTY	Teletype.
UPS	Utility Program Subsystem.

VDT	Video Data Terminal.
WPM	Words-per-Minute.
XMITTED	Transmitted (abbreviated).
ZDK	Operating Signal, "The following repetition is made in accordance with your request."
ZEN	Operating Signal, "Transmitted by other means."

I. INTRODUCTION

A. BACKGROUND

Since the earliest communications systems were developed there has been an ever-increasing demand placed upon them as users of these systems utilized them to greater extent. The United States Navy communications systems have likewise been in a growth stage since their inception and previous attempts to handle this increasing volume of narrative traffic consisted of placing more men and machines at selected communications sites. However, with the quantum jump in traffic brought about by Management Information Systems (MIS), greater reliance on communication systems for command and control, high manpower costs and advancing technology, a computerized communications system interfaced over reliable, high speed channels was formulated and developed.

1. Manual Processing Problems

Since 1964, the Navy has been automating various functions of communications stations in an attempt to keep an ever increasing narrative message volume flowing between users while maintaining information currency demanded by command MIS. However, the early stages of the automation programs were unsuccessful as highlighted by exercise BASELINE II, conducted in 1966, which clearly showed that

message handling delays for higher precedence traffic were grossly unacceptable. Further, this exercise established that these delays were principally "waiting to be processed" times in the sender's and receiver's communication centers.

2. Decision to Use Computerized Systems

As a result of Baseline II, Naval communications was taken under study by the Chief of Naval Operations in 1968 for the implementation of an integrated information system capable of interfacing with all Naval data bases throughout the world. Additionally, human errors, which include unacceptable message processing delays, were on the increase due to undermanning, inadequate training, overloading, inattention, etc. The final problem arose with the manpower and budgetary reductions of the late 1960's and early 1970's which accelerated consolidation of existing communications facilities. This meant that the consolidated communications stations workloads were significantly increased as message volumes were concentrated into fewer lines. Therefore, it became evident that computerized automation was essential to reduce or eliminate routine human functions such as logging time of receipt(TOR) or, time of deliveries (TOD), message identification, filing, etc., which are most prone to

error as well as achieve optimum interface capability with other computerized stations.

Due to its high speed and accuracy, use of a computer does allow message traffic volumes to increase while significantly reducing errors. However, it is recognized that the computer cannot totally eliminate all causes of delay and error. Additionally, it can collect, tabulate and format information into required periodical reports for managerial use and, thus, free the human communicator from routine tasks in order to allow him to give more attention to the management of the system.

In view of the foregoing, Commander, Naval Telecommunications Command (then, Naval Communications Command) developed the Naval Communications Automation Program Subsystem Project Plan (SPP) which provides for the time-phased evolution from manual communications processing to the automated "one Navy memory" concept, i.e., a network of Navy computers employed by different systems and commands which will allow computer-to-computer interrogation and reply. Its primary objective is to satisfy the overall requirements for speed, reliability, security and systems compatibility vice ADP which eliminates manual processes with its attendant errors and delays.

Specifically, this automation plan calls for:[1]

(1) Increased speed of service to meet JCS stated user-to-user handling times,

(2) Reduced error rates to less than one percent of the message traffic handled.

(3) Reduced security violations.

(4) Increased reliability by reducing non-deliveries and mis-routes to less than one in ten million (10^7).

(5) Handling of up to 8,000 messages per day and supporting new requirements without large system upgrading procedures and attendant personnel retraining.

3. Three Phases of Automation

The concept of automation in the Navy has been divided into three phases to allow an orderly transition or evolution of communications processing through a thorough study of each phase. This, in turn, hopefully will lead to a "one Navy memory" at the lowest overall cost. It should be noted that an economic analysis is conducted for each module and communications facility considered for automation. However it is not the purpose

---

[1] Naval Telecommunications Command, Naval Communications Automation Plan (U) Subsystem Project Plan (SSP), May, 1972.

of this paper to discuss the determination process of "lowest overall cost."

Phase I - INITIAL AUTOMATION (1968-1971)

This phase, commenced in 1968, consisted of studies by the Navy and the Joint Chiefs of Staff to identify certain manual communications processing functions in need of immediate automation. Additionally, and in conjunction with these studies, certain processing functions in designated communications centers were semi-automated such as limited automatic formatting, editing and file and retrieval functions, and distribution assignment. These were, out of necessity, offline to the communications networks.

As a result of these studies and observations, specifications for the Local Digital Message Exchange (LDMX) were formulated and submitted for competitive bid during 1969. Prior to the delivery of the first unit (destined for Naval Message Center, Pentagon) a degree of standardization and user interface facilitation was obtained by coding many portions of the LDMX software in COBOL vice machine language.

Phase II - INTERIM LDMX/NAVCOMPARS (1971-1976)

Based on the numerous and extensive studies conducted, this phase concerned itself with the acquisition and implementation of the Local Digital Message Exchange and Naval

Communications Processing and Routing Systems (NAVCOMPARS). The LDMX system was designed to facilitate shore commands and/or ships inport communications by local processing into and out of a AUTODIN network. However it should be noted that LDMX does not provide a fleet interface via fleet broadcast. On the other hand, NAVCOMPARS does provide local traffic distribution while maintaining an interface with the fleet at sea via fleet broadcasts. Though present state-of-the-art is not sufficient to meet the standardization desired at this time, it will contribute in the future to the development of new systems as well as partially alleviate current problems. Additionally, during this phase, when equipment is on-line and operating, doctrine and procedures will be studied and changed for future completely automated systems. It should be noted that some difficulty has been encountered during the implementation of both LDMX and NAVCOMPARS at selected sites in arranging standardized hardware and software configurations.

Finally, a study has been undertaken during this phase to provide the complement of NAVCOMPARS (ashore) aboard ship: namely - the automated Message Processing and Distribution System (MPDS). This latter system will not be considered in this paper.

Phase III - COMMUNICATIONS AUTOMATION (1976-1980's)

Based on studies and analysis conducted on LDMX and NAVCOMPARS during Phase II, plus earlier studies conducted during Phase I, the LDMX and NAVCOMPARS systems will be upgraded and standardized to provide a totally automated and integrated communications system utilizing digital processing.

B. NAVCOMPARS DESCRIPTION

NAVCOMPARS is an application of modern ADPE technology and procedures designed to interface shore communication networks with multichannel ship/shore circuits for control of operational fleets. It is capable of accepting traffic from two AUTODIN mode I channels (dual homing concept) and complies with the criteria as set forth in DCAC-370-D175-1. As an automated communications processor it was designed to handle fleet center functions such as: screening, formatting, servicing messages, maintaining a real-time fleet locator, readdressal and routing of messages as dictated by environmental and operational conditions. An overall system block diagram and equipment configuration drawing appear in Figures 1 and 2 respectively.

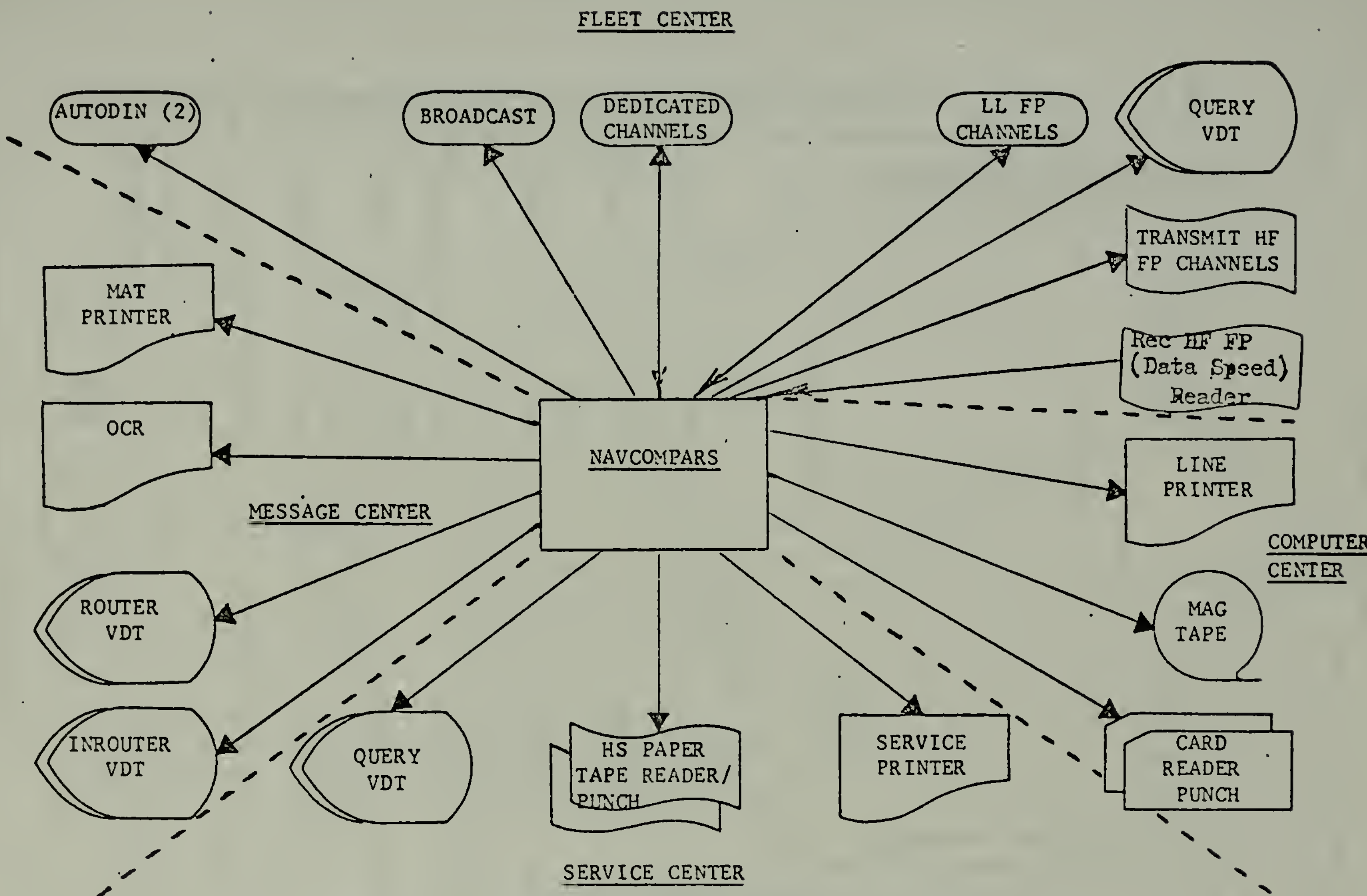
1. Input Functions

The system is designed to accept traffic from the following: AUTODIN switching centers; on-line dedicated/ full period channels; off-line dedicated/full period

channels; high and medium speed paper tape readers; optional character readers (OCR's); video data terminals (VDT's); card readers; and magnetic tape.

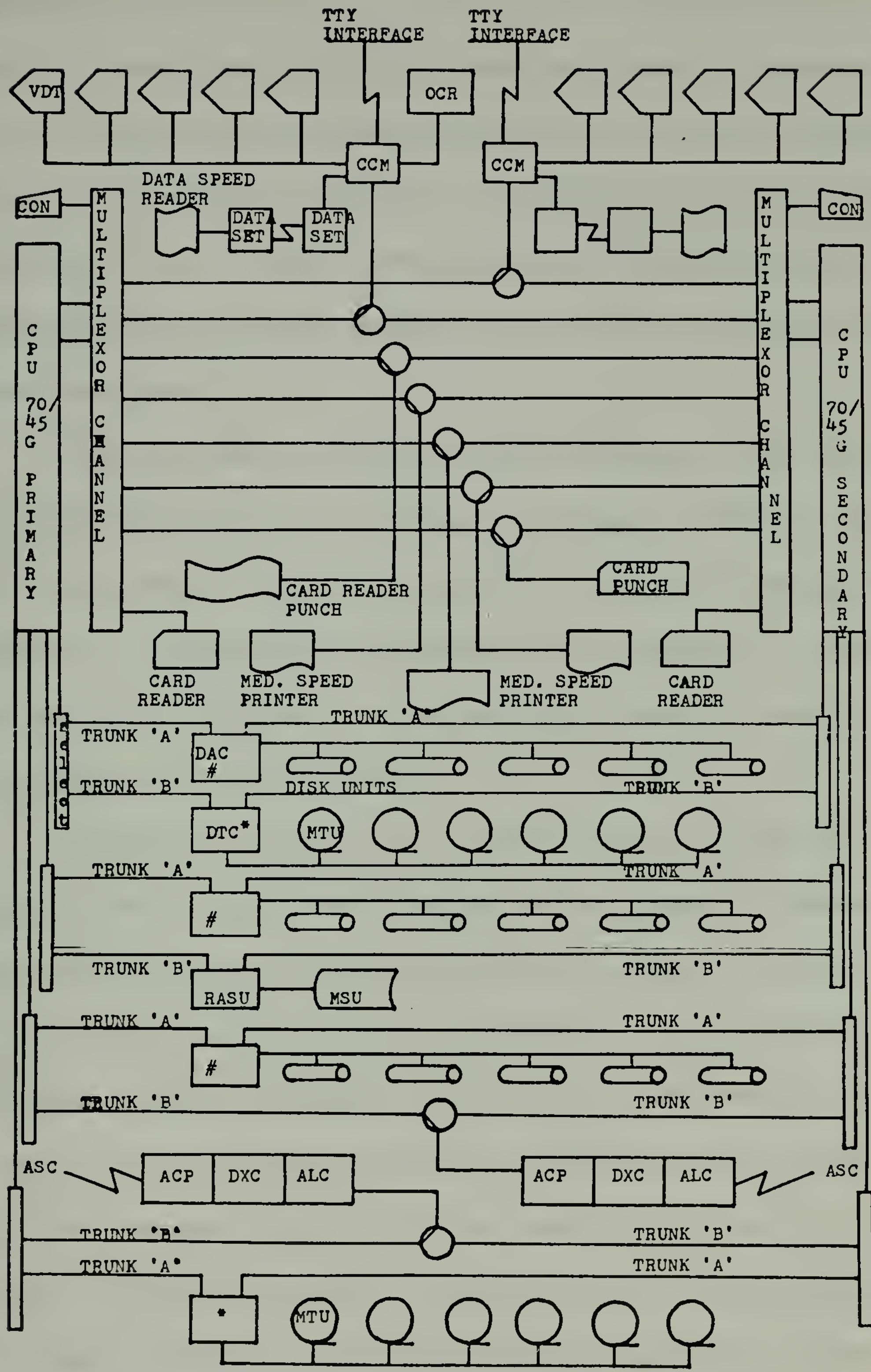
Messages entering from AUTODIN are handled through a UNIVAC 161108 (AUTODIN Communications Controller, ACC) front-end processor, one for each AUTODIN line with appropriate decryption devices. Though presently configured for transmit/receive at 1200 baud, these processors are capable of handling up to 2400 baud. They perform the following functions automatically: acknowledge all received line blocks; generate and transmit the proper receive control characters; examine the header block for a valid AUTODIN select character; check the receipt of correct receive control characters; receive the transmitted data; coordinate the transfer of data between the on-line UNIVAC 70/45G and the front-end processor (ACC) storage area; and generate and check block parity for all blocks transferred between the ACC and the AUTODIN network.

On-line dedicated/full period channels, such as electronic courier circuits, are interfaced directly to NAVCOMPARS via a Multichannel Communications Controller (CCM), a communications coordinating device which provides control over data transmissions and the associated communications systems, on a multiplexer channel. These lines



NAVCOMPARS OVERALL SYSTEM BLOCK DIAGRAM

Figure 1



NAVCOMPARS EQUIPMENT CONFIGURATION

Figure 2

are buffered, half duplex and must be of land-line quality capable of handling up to 1800 baud for direct interface. The use of Multichannel Communications Controllers permits the system to handle up to 256 such channels without system degredation. These lines are normally cryptographically covered and must undergo decryption prior to entry to the control processor.

Off-line dedicated/full period channels are those not of sufficient quality for direct system interface or those which entail off-line (manual) encryption/decryption procedures. For channels falling in this category, medium speed printers (125 lpm) and paper tape readers located in the fleet center are used.

Though the video data terminals may be used for message input, their normal usage is for operator interaction with the system for correcting messages in the system or calling upon the various files as in the case of service message requests. These units are small, desk top, manually controlled devices, that permit real time operations between router stations and the central processor. They are capable of displaying 64 alpha-numeric characters in 22 lines of 81 characters per line, operate on buffered, half duplex lines to the CCM's and are automatically validated.

The optical character readers are, currently, leased Cognitronics System/70 equipment and are the main source of message entry for over-the-counter (OTC) service provided local commands. This equipment reads a standard OCR on DD form 173 typewritten messages. Its channel is buffered, half duplex to the CCM at 1800 baud. Message format is modified ACP 126 to decrease message preparation time and to enable the system to automatically perform routing indicator (RI) lookup, i.e., comparing the short titles of the addressees on the message against those in the present Routing File, and format conversion to JANAP 128 procedures. In the event of OCR malfunction, the high speed paper tape reader in the service center is used for message entry after tape preparation.

Magnetic tape input is on one-half inch, nine channel tape with a read/write/transfer rate of 30,000 characters per second. Five and seven track tape options are also available. These devices are connected to the main processor via appropriate selector channels.

Standard ship/shore communications via HF links are handled by standard torn tape procedures at the receiver site. Two human checks for validation are performed upon receipt and, once certified correct, the tape is entered directly to NAVCOMPARS on a dedicated circuit via

high speed (1000 characters per second) paper tape readers.

All inputs via OCR, VDT and paper tape readers utilize modified ACP 126 procedures which reduce user message preparation time. NAVCOMPARS automatically activates the modules necessary to convert to JANAP 128 procedures including routing indicator lookup.

Satellite communications are effected through a SPERRY UNIVAC AN/YUK - 20 minicomputer interfacing the earth station terminal and NAVCOMPARS. This processor has a 750 microsecond 16-bit word core memory capable of expansion to 65K word total. It has an exceedingly flexible microprogrammable control section which provides a very fast computing capability. The AN/YUK - 20 provides
UYK
standard front-end processor functions.

2. Processing Functions

At the heart of NAVCOMPARS are the two solid state, high performance UNIVAC 70/45G main processors capable of handling real-time interaction of video display terminals with the computer, as well as communications applications of incoming/outgoing narrative traffic processing. Each processor has a modular main memory of about 393K bytes, capable of off-the-shelf expansion to 1,024K bytes by 64K byte modules. It is capable of addressing fixed length

units of data of 1, 2, 4, or 8 bytes for processing. It uses sixteen general purpose registers as data accumulators of arithmetic and logic operations, base-address and index registers, and repositories for editing data. Data handling, decision, control, decimal and fixed point operations are performed by a standard instruction repertoire. The system is capable of handling fifteen levels of memory separation and is equipped with a protection procedure to ensure program/memory integrity in a multiprogramming environment. An interrupt system responding to various internal and external conditions, in conjunction with the capabilities of the selector and multiplexor channels, permits I/O activities to be conducted simultaneously with processor functions.

Projected system reliability is high due to the massive hardware duplication in NAVCOMPARS. Hardware failures will not seriously degrade the system. In the case of on-line processor malfunction, the off-line processor automatically goes on-line with the only loss being report generation and other miscellaneous activity. A power failure detection device alerts the software system (by interrupt) with sufficient warning to quiesce I/O devices, store register contents and perform such functions as are required to facilitate recovery. The initialization and restart module provides for near automatic restart with limited operator control.

Four selector channels with two trunks each permit I/O operations to be completed with discs, tapes, mass storage unit, and AUTODIN front-end processors. There are three disc units, each containing five disc packs. Each disc unit has a storage capacity of 145 million bytes and a data transfer speed of 156,000 characters per second. There are two tape units with six drives each. If off-line storage is considered, then storage capacity is unlimited. The tapes are standard one-half inch, nine track with a read/write/transfer rate of 30,000 characters per second. The mass storage unit has a storage capacity of 556 million bytes with a 600,000 character per second transfer rate. It should be noted that the standby processor is capable of accessing the direct access storage devices during off-line operation.

The following is a summary and brief description of the major program (software) subsystems:

Executive Control Subsystem (ECS) - The ECS is responsible for the real-time control and monitoring of system resources. This system interfaces the remaining sub-systems with one another and ancillary equipment. In real-time it performs device controlling, program monitoring, interrupt analysis, and operator liaison.

Communications Control Subsystem (CCS) - This system interfaces the various communication type devices used in the system, i.e., visual display terminals, low speed printers, teletype circuits, both send and receive, and high speed and receive circuits.

Communications Interface Subsystem (CIS) - Provides real-time control over AUTODIN mode I operations in the following areas: line coordination, network control, system logs, line processing, and start-up and shut-down operations.

AUTODIN Processing Subsystem (APS) - Maintains an AUTODIN processing capability during outage of the control processors.

Utility Program Subsystem (UPS) - Performs channel coordination, input buffering, and format conversion.

Message Processing Subsystem (MPS) - Performs message validation, message routing, format conversion from modified ACP 126 to JANAP 128 format, distribution assignment, message file, readdressal/retransmission, and query VDT operations.

Transmission Processing Subsystem (TPS) - Performs transmission line control, channel scheduling, broadcast channel activity, AUTODIN channel selection, message altrouting and message journaling.

Transmission Control Subsystem (TCS) - Responsible for transmission identifies line generation, formal conversion/editing, routing line segregation, and broadcast rerun.

Support Program Subsystem (SPS) - Performs file maintenance, report generation, off-line message processing and off-line message recovery.

3. Output Functions

Messages exit NAVCOMPARS by the same units described in inputting except as noted below:

Unit record (card) traffic utilizes a UNIVAC 70/234 10 write (check read) card punch capable of a rate of 100 cards per minute.

Over-the-counter (OTC) service is outputted on medium speed printers or paper tape cutters and manually processed.

The OCR is, by its nature, an input only device.

The VDT's are used for system query and response such as in service message reply generation and not for standard message output.

Fleet broadcast channels are automatically connected to NAVCOMPARS through appropriate encryption devices for messages addressed to afloat units guarding one or more of the broadcasts. These channels are 75 baud, (100 words per minute).

C. LDMX DESCRIPTION

LDMX is designed to exchange data with and between on-line ADP centers, control pooled transmission facilities, and process narrative as well as data messages. It is capable of accepting traffic from two AUTODIN mode I channels (dual homing concept) and complies with the criteria set forth in DCAC-370-D175-1. For specific fleet oriented functions, NAVCOMPARS software modules may be fitted to the LDMX system. An overall system block diagram and equipment configuration drawing appear in Figures 3 and 4 respectively.

1. Input Functions

The input to LDMX is from both on-line and off-line means. The system receives narrative on-line traffic via an interface with AUTODIN and dedicated teletype circuits. Off-line (over-the-counter or mail) is manually prepared for input. The most desirable manual, off-line, input is via an optical character reader (OCR), otherwise input by means of a less desirable form (paper tape) is utilized. After message receipt, it is disc stored on the "In-Processing File."

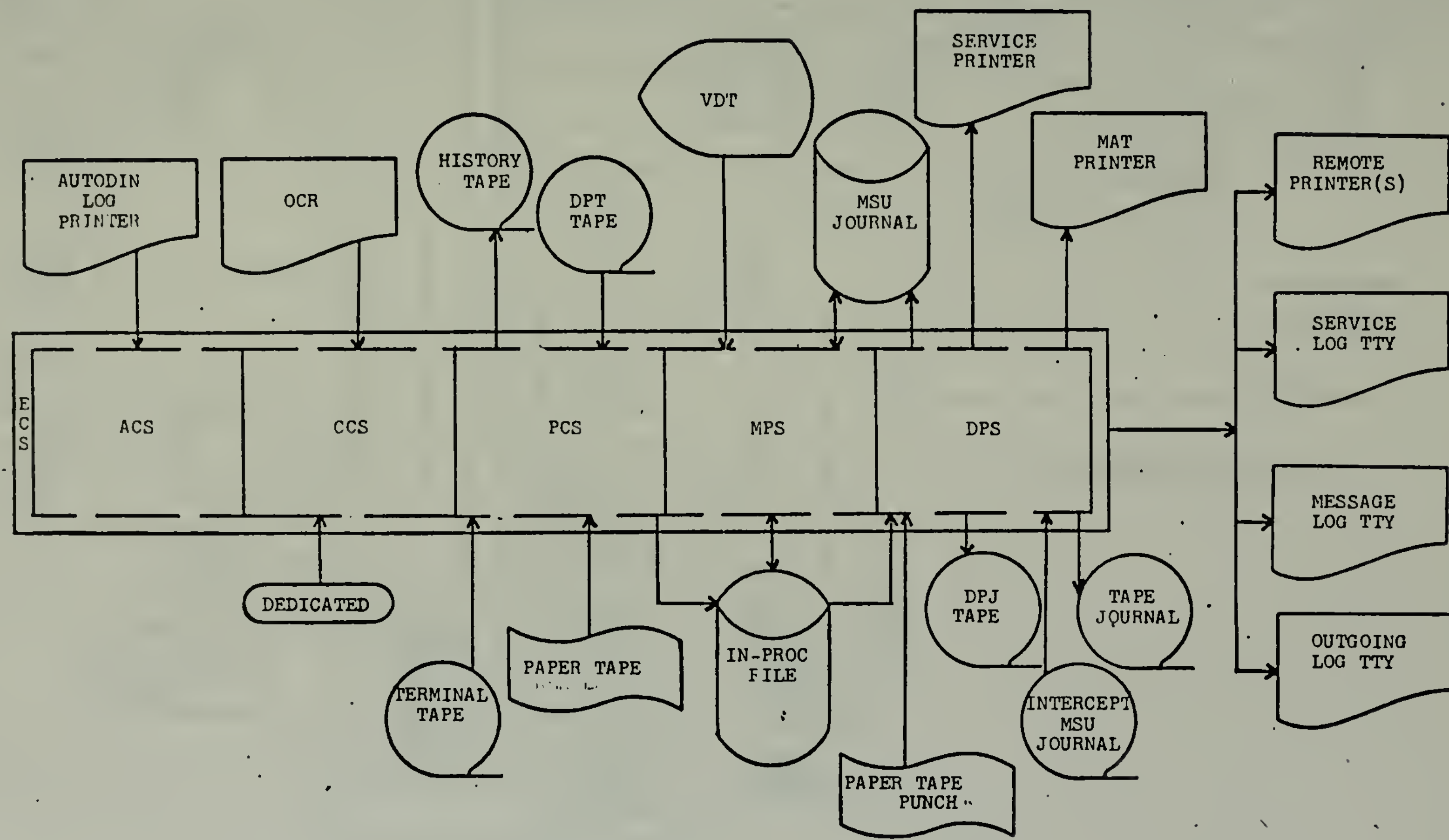
2. Processing Functions

Once a message is in the "In-Processing File," it is queued for processing and is also recorded on magnetic tape in the "History File."

Messages are processed from the queue on a basis of precedence in the following descending order: Emergency Command (Flash Over-Ride), Flash, Immediate, Outgoing Priority, Incoming Priority, and Incoming/Outgoing Routine. Once out of the queue and actual processing commences the system analyzes each message and determines the following information: classification; precedence; station serial number; date-time-group; originator; operating signals; addressee delivery responsibility; content indicator code; subject code; originating office; flagword; and reference. Under ideal conditions the message will be processed directly through the system without human intervention.

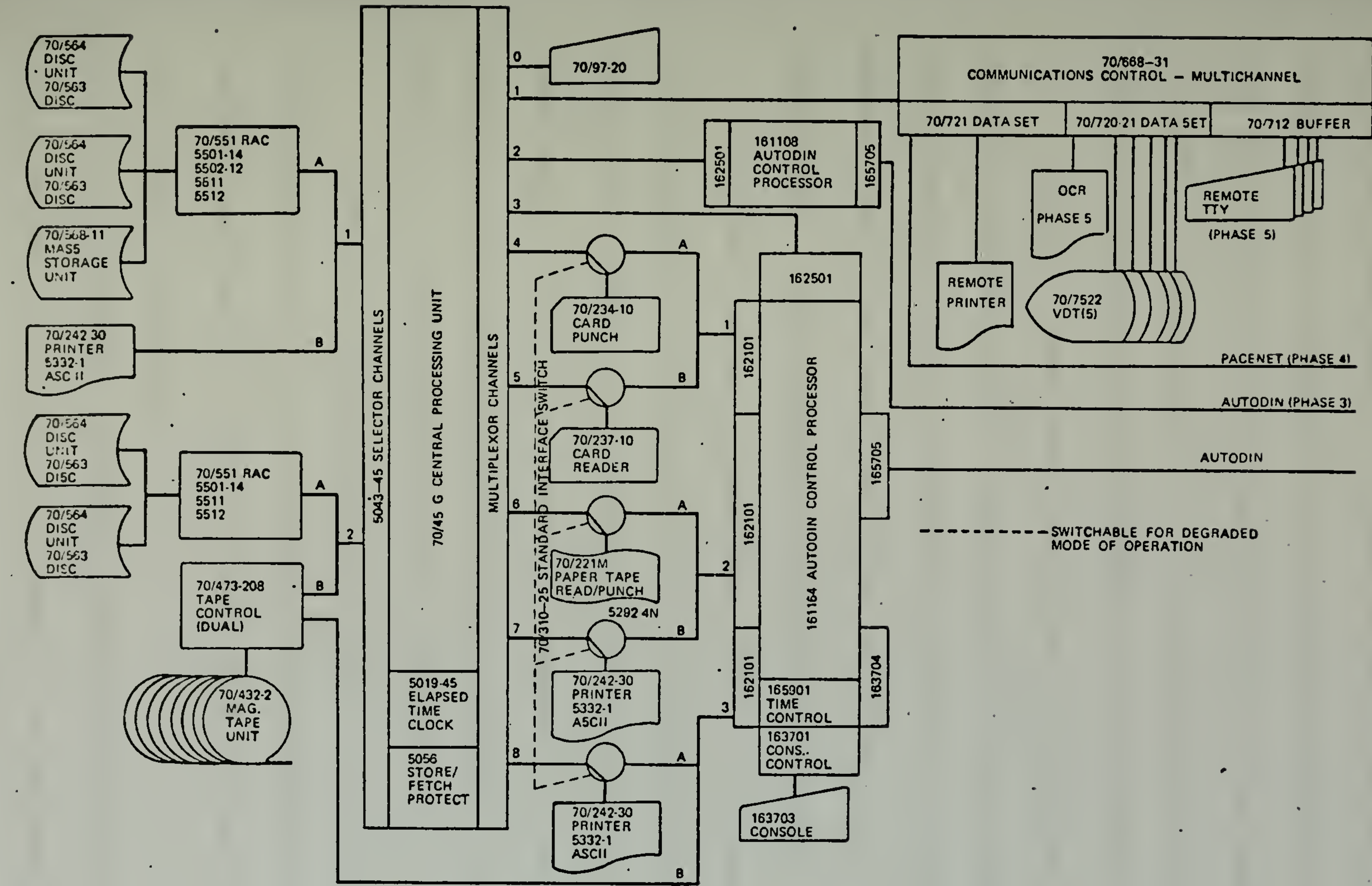
Messages with processing restrictions or format errors will necessitate a VDT display at the Inrouter station for incoming messages, and the Outrouter station for outgoing messages, for processing assistance. Once the error is corrected it is transferred back into the system for final automated processing.

During processing a printer records incoming dedicated traffic. In addition to circuit monitoring, this system maintains a message and service log. The service log receives entries for each message requiring a service operation and the message log receives an entry for all incoming and outgoing messages processed through the system.



LDMX OVERALL SYSTEM BLOCK DIAGRAM

Figure 3



LDMX EQUIPMENT CONFIGURATION

Figure 4

As noted earlier under NAVCOMPARS, the SPS performs all report generation in support of main processing. The "Journal File" maintains key information extracted from each message during the processing cycle. The report generation programs provide a dump and listing at the close of each radio day (0000GMT) or on an ad-hoc basis.

Software programs within LDMX include the Executive Control Subsystem (ECS), Communication Control Subsystem (CCS), Message Processing Subsystem (MPS), and Support Program Subsystem (SPS) described previously under NAVCOMPARS. Other programs and descriptions are:

Process Control Subsystem (PCS) - This subsystem is responsible for all tasks akin to message input, preparation and filing. It interfaces with the CCS and performs input line polling, message preparation, and accepts messages from transmission media, i.e., paper tape, AUTODIN, OCR, on-line dedicated circuits and magnetic tape.

AUTODIN Control Subsystem (ACS) - The ACS performs I/O functions only. It interfaces with AUTODIN Switching Centers (ASC) and, in short, is the front-end processor for the main frame facility.

Distribution Processing Subsystem (DPS) - This subsystem responsibility lies in output line segregation and all message output to the media, such as, AUTODIN circuits,

dedicated circuits, mat printer, service printer, paper tape or magnetic tape.

Fallback Subsystem (FS) - Since Navy policy usually dictates redundancy, this subsystem, by using suitable peripheral equipment from the main frame, has the capability to send and receive paper tape traffic between the ASC and ACC in the event of main frame outage.

A capability is provided for retrieval of messages previously processed. Message identification parameters must be entered via a VDT terminal. New messages are retrievable from disc storage and traffic, up to 45 days old, is retrieved from the mass storage unit. Traffic older than 45 days must be sought from the properly selected magnetic tape "Journal File Tape Library." The operator has the capability to select the retrieval output in the form of paper tape, card and/or hard copy.

3. Output Functions

Outgoing narrative messages entering the processor will receive processing similar to an incoming message. The exception lies in the fact that the originator and ZEN/lines, i.e., delivered by other means, will be analyzed for delivery responsibilities. After the start and end of message validation, the processor outputs either an accept or reject notice to the operator by means of the outgoing

log. A Processing Sequence Number (PSN) is assigned and the message is queued for precedence processing. Once the message has been prepared and routing appended to the message, the information is permanently stored in the system's journals.

D. LDMX/NAVCOMPARS Common Functions

There are three areas or functions common to both LDMX and NAVCOMPARS worthy of mention; namely, report generation, security, and system monitoring. Each is a decided advance over older manual methods as they allow human interface with the system at a higher level than ever before.

1. Report Generation

In the past, reports were prepared manually and much time consuming, tedious work was devoted to this task. Due to inherent delays in this method, reports were often outdated and, hence, nearly useless to the individual concerned with managing a communication system or parts thereof. From information stored in the on-line message file, reports from LDMX and NAVCOMPARS contain:

"Total messages processed.

"Messages processed by channel

"Breakdown by precedence and classification for each channel.

"Total messages by precedence and classification.

"Total number of service messages processed.

"Number of suspected duplicates.

"Total received ZCV messages.

"Messages misrouted to the NAVCOMMSTA.

"Average message length, with a breakdown by classification and precedence.

"Number of messages requiring operator intervention.

"Breakdown of manual/automatic distribution assignment.

"Messages delivered to commands on guard list.

"Channel utilization (in minutes) for each channel (Approx.).

"Channel loading by work/count.

"Hourly message processing profile."[2]

2. Security

In the past, communications security within the Naval Communications Facility was provided by limited access to the various centers in operation as most traffic was in plain text on hard copy or paper tape with encryption/decryption devices being provided on incoming and outgoing channels. In LDMX and NAVCOMPARS, the direct application of crypto devices to incoming and outgoing

---

[2] Naval Command System Support Activity Document Number 84C042 FD-01, Automation of NAVCOMMSTA Honolulu Functional Description (Draft), p. 52, August 1973.

channels is still provided. However during on-line operation security required by the user is provided by hardware, in that hardware creates the interface between the communication link and communications station and is specifically designed to protect line security and the software which specifically controls processing. During maintenance periods, the tapes or discs on which the journal or history files reside may be conveniently removed and stored in appropriate security containers. However, on traffic which requires human intervention, the system still requires communications personnel to have appropriate security clearances.

3. System Monitoring

LDMX and NAVCOMPARS system monitoring is broken into two sections. The first is monitoring of hardware and software by a computer operator who interfaces with the system via a console. The second is monitoring message processing by operations personnel utilizing VDT's in the message center, service center, and fleet center.

II. SIMULATION OF NAVCOMPARS

A. STATEMENT OF THE PROBLEM

As no definitive information exists indicating where NAVCOMPARS degenerates with abnormal message load, it is the intent of this paper to identify those areas most prone to developing bottlenecks. In a communications system such as NAVCOMPARS, it is necessary to provide documentation where queues occur and determine the average time messages spend waiting to be processed. An attempt has been made to accurately represent system flow and to identify potential bottlenecks. Additionally, as a by-product of this investigation, a model for use by operational managers was developed which, if utilized, would provide personnel with the ability to monitor and tune a NAVCOMPARS installation.

In identifying potential bottlenecks in system flow there are two approaches which may be taken; first, the use of queueing theory and, second, simulation. The complicated relationships among precedence, message length, processing time and channelization complicates any analysis of NAVCOMPARS to the extent that simple queueing calculations are not sufficient to predict the effect of changes in traffic load, variable message lengths, incoming and

outgoing traffic alignments, processing times or management techniques. To provide a tool for addressing such problems, simulation allows complex, variable, real-time transaction input and processing as well as providing a means of analyzing the system under a continuous flow situation.

B. SYSTEM SIMULATION MODEL

Three methods of simulation were considered for the analysis: (1) manual, (2) FORTRAN IV, and (3) IBM General Purpose Simulation System (GPSS/360). The manual form of simulation was not used because of the high volume of transactions encountered in NAVCOMPARS. FORTRAN IV, though not ideally a simulation language, was disregarded as its ability to detail complex items was not required. As such, GPSS/360 was finally decided upon.

1. General Purpose Simulation System

The General Purpose Simulation System is very adaptable to defining a functional model of NAVCOMPARS for the purpose of identifying bottlenecks. It has the capacity of representing "black-box" functions while maintaining the required multichannel/server representation through the use of TRANSFER statements. The greatest flexibility of GPSS, however, is the use of FUNCTION statements which may represent theoretical or

empirical distributions and are easily interchanged to observe the effect of different distributions within the model. Additionally, transactions may be generated according to time between inputs, message length and precedence distribution. Precedence is important because higher priority transactions are processed before those of lower priority.

The general sequence of events at a facility or server is given by the following in GPSS: QUEUE, SEIZE, DEPART, ADVANCE, and RELEASE. A QUEUE is a point where traffic or transactions may be held or delayed by the unavailability of the facility it intends to utilize and where queue statistics are gathered. When the facility seize.? is free, the next transaction gains entry to the facility, on a first-in/first-out (FIFO) within precedence basis. At this point the QUEUE is DEPARTED. The ADVANCE statement allows a service time to be computed and applied to the transaction through a fixed time specified by the user or by the use of VARIABLE and FUNCTION statements which allow varying delays to be introduced into the system. When a facility is finished with a transaction, the transaction RELEASES the facility and moves to the next area identified in the program.

GPSS maintains and generates facility statistics and queue statistics[3] as a normal output. These statistics are specified in the basic unit of time specified by the user.

2. System Model Description

The message flow simulated by this model is a functional representation rather than a detailed simulation of individual NAVCOMPARS system components. The model provides a means of testing proposed or actual message input distributions, processing times and broadcast alignments without incurring the actual costs and difficulties normally associated with an actual system change. In addition, the model is versatile enough to help analyze many traffic flow problems, such as identifying bottlenecks in queues and establishing activation criterion for an overload fleet broadcast channel, if so desired.

Message arrivals of each precedence are simulated from arrival rates which may be specified as functions of time. The arriving messages are assigned precedence, classification, message length, etc. according to an empirical distribution that segregates messages to the five precedence level queues in the main processor.

---

[3] See Appendix D.

The distribution was determined from two days of actual data obtained from the U. S. Naval Communications Station, Norfolk, Virginia. The main processor polls each precedence queue and simulates message processing on a FIFO within precedence basis. The processing time through the main processor (POUT) is computed as a function of message length, average number of instructions required per character, and instruction execution time. Another developed empirical distribution segregates messages to one of four fleet broadcast channels or to an "Other" channel for over-the-counter service, electronic courier circuit, etc. Each of the four fleet broadcast channels have separate queues associated with them and transmitting times are computed as a function of message length and the number of words-per-minute transmitable by radio teletype. The messages are transmitted out on each channel on a FIFO within precedence basis. Figure 5 provides a pictorial representation of the model.

The NAVCOMPARS simulation, developed in this thesis, can be operated under continuously varying traffic loading conditions specified by the following input data:

(1) Daily and hourly volume of first-run message arrivals. This parameter can be stepped over a range of values to simulate operations under varying traffic conditions.

(2) Precedence of each message.

(3) Individual message length distribution. Message lengths determine the rate at which messages can be processed and transmitted.

(4) Diurnal variations in message arrivals. Studies of message traffic indicate that strong diurnal variations exist in the arrival rate of messages to a communications station for delivery.

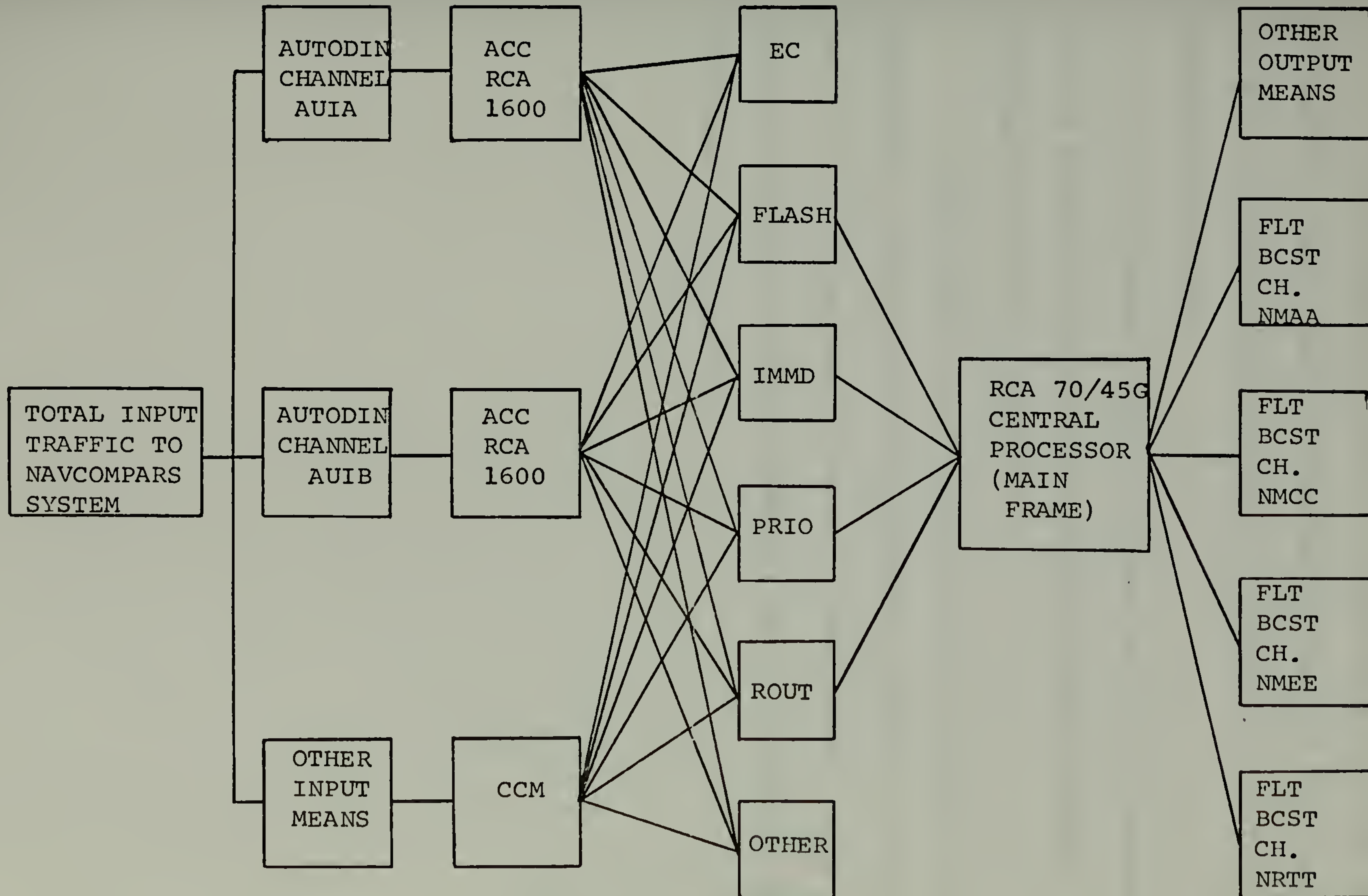
(5) Message type composition. The message type composition indicates the portion of arriving traffic which is segregated into each of the queues.

(6) Classification of each message.

In addition to traffic loading, the performance of NAVCOMPARS is affected by the following operational parameters:

(1) Main processor service time. This value affects system through-put and was based on the UNIVAC 70/45G instruction execution time and average number of instructions required per character for processing in the runs made for this thesis.

(2) Front-end processor service time. The value of service time per character was estimated at approximately one millisecond per character through-put to disc storage.



NAVCOMPARS MODEL

Figure 5

(3) Broadcast channels transmitting service time. The service time value utilized herein was for the standard 100 WPM teletype broadcast using an average value of six characters per word.

(4) Channelization. Channelization of message flow is determined by inputs specifying which messages may flow out of which channels.

When loaded with the above inputs and given the operational parameters, this simulation generates a time profile of the important features of NAVCOMPARS. This profile consists of hourly summaries for a 24 hour period contained in Appendix D.

III NAVAL COMMUNICATIONS PROCESSING AND ROUTING SYSTEM SIMULATION RESULTS

In order to evaluate the model as developed and observe the resulting statistical generation, a series of eleven computer runs were made. During these runs certain parameters were allowed to vary or be held constant in order to observe the models interrelationships. These parameters were traffic volume and message length. Although the simulations do not delineate message length per message in an output format, the changes in message length could be observed indirectly as a result of the main processor (POUT) and fleet broadcast channel queue's average time per transaction. This is because message length is a controlling factor of message processing time.

A. SIMULATION BASED ON ACTUAL DATA FOR TWO DAYS

Based on the data for two days received from Naval Communications Station Norfolk, Virginia, it was determined that the hourly arrival rate of messages was cyclical over each 24 hour period as denoted in Figure 6. The average arrival rate per hour for a 24 hour period was used in the simulation program. Using the average hourly arrival rates, a constant interarrival rate was computed per hour of simulation and used in 24 separate

ACTUAL DATA INPUT FOR SIMULATION

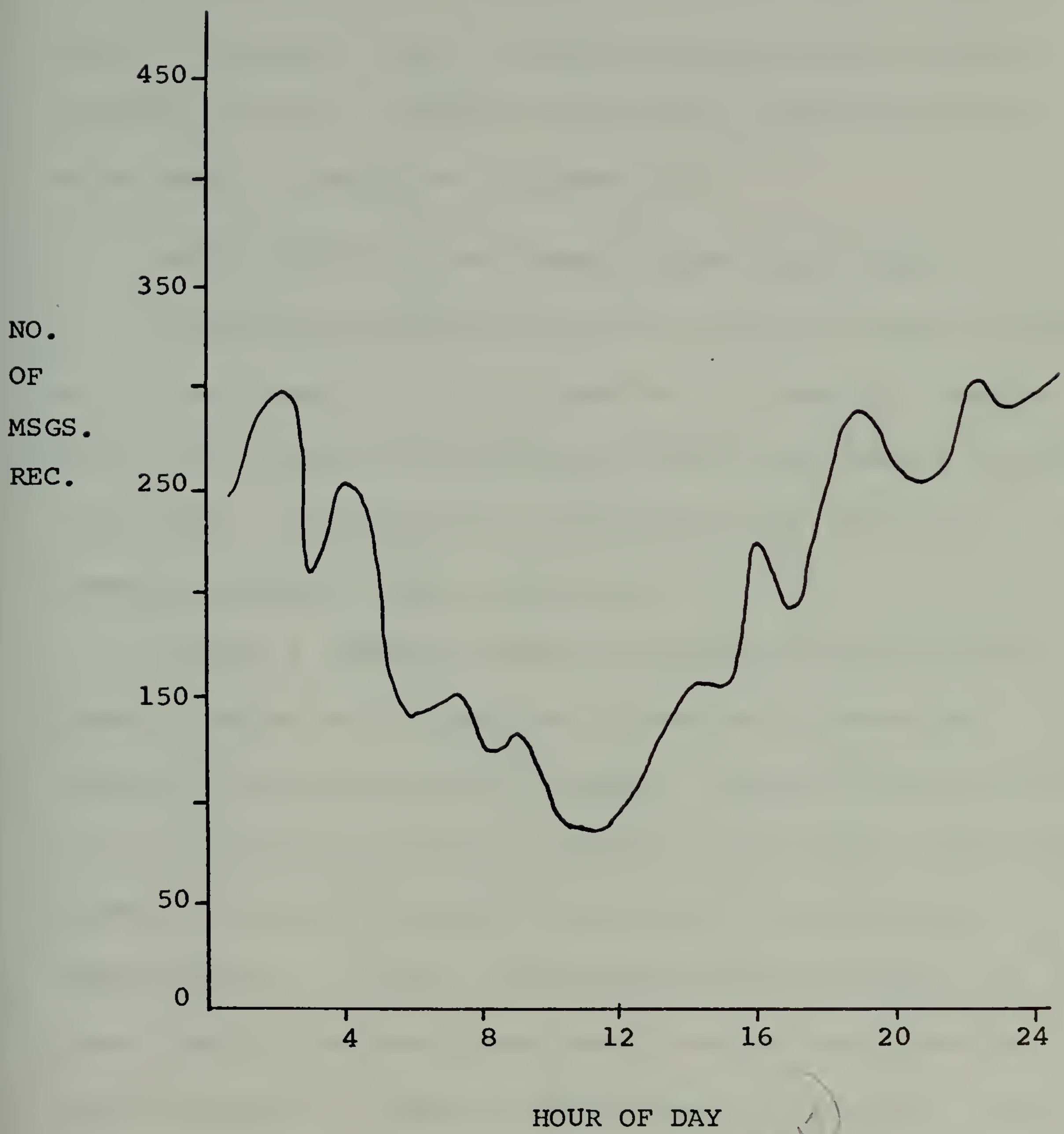


Figure 6

GENERATE statements. The peak hour occurred immediately prior to and after midnight GMT. This most closely resembled the actual input for the two days of observed data.

The results of the simulation indicate that queues build during peak hours and decrease as the load lessens through the day. A sample statistical generation of this simulation is contained in Appendix E.

B. TWENTY FOUR HOUR TEST DATA IN CASE 1 AND CASE 2

As previously noted, actual data for two days indicated a cyclical type input to the system. In order to observe facility utilization and queues, under other message loading conditions, two cases were constructed with increased message loadings during peak periods.

In Case 1 message traffic increased rapidly after two hours, leveled off at its peak values for a three hour period, and then decreased rapidly. During the simulation it was noted that for these message input levels, the system quickly cleared its queues while facility utilization remained low. In Case 2 the peak was almost double that of Case 1 while the lower input rate remained four times as great as Case 1. Figure 7 is designed to show Case 1 and Case 2 in contrast with the actual data arrival rates for the two days of actual data.

CASE SITUATIONS FOR SIMULATION

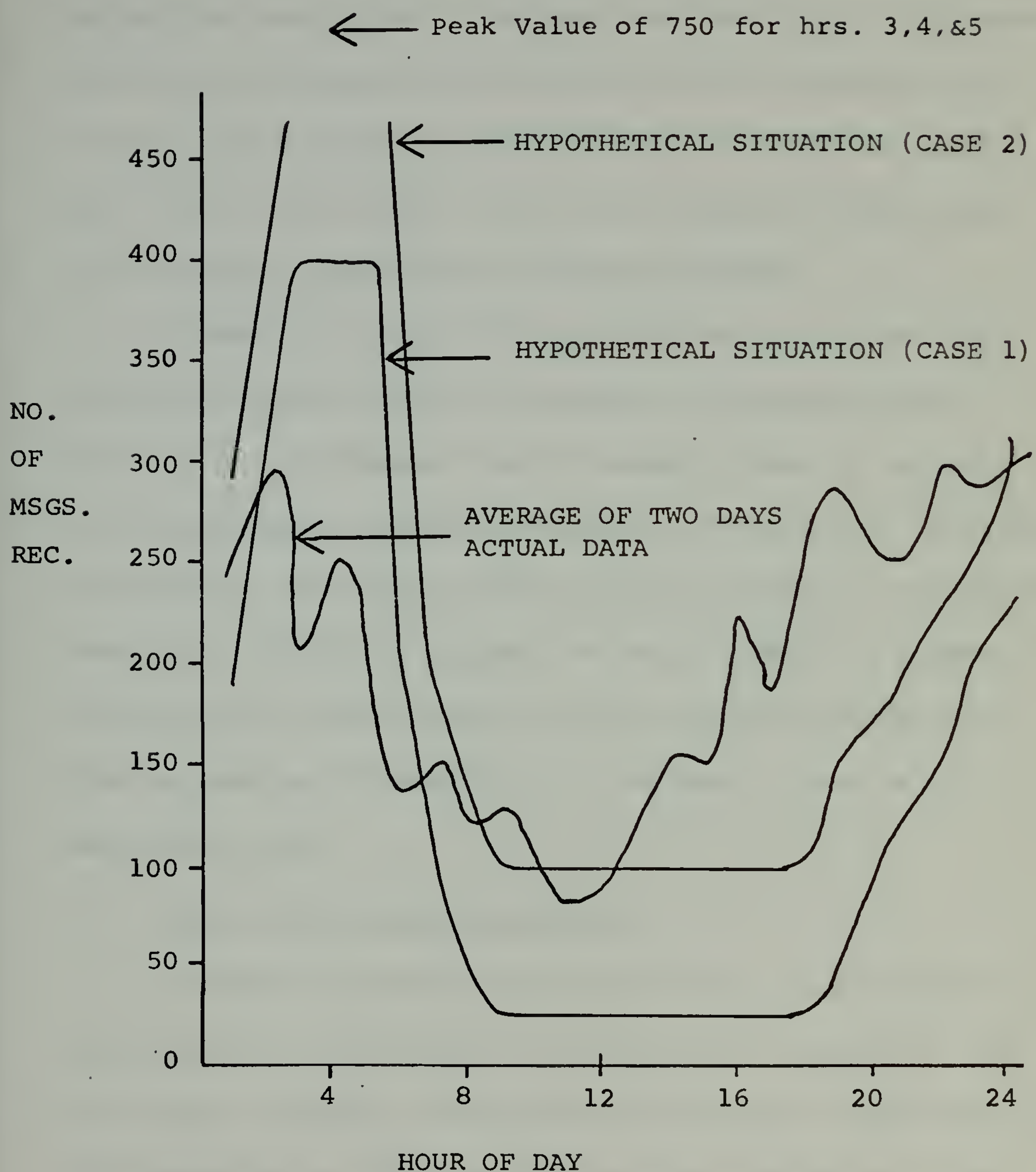


Figure 7

The results of Case 2 were more accentuated due to queue build-up as facility utilization percentage rose during the peak hours. Once the last peak hour of message arrivals was completed and the input rate decreased, all of the queues required approximately two hours to reach a peak, thus indicating a lag of the internal system queue build up after peak message arrival periods.

By observing the build up of queues at the main processor and fleet broadcast channels, a Communications Officer of a NAVCOMPARS could determine when to activate auxilliary fleet broadcast channels to handle the overloaded conditions. The actual queue loading factors in the system requiring auxilliary channel activation would be dependent on each individual command's policy for such situations. This is another illustration of the model's use as a management tool.

C. LARGE INPUT VOLUME SIMULATION

In order to observe the rapid build up of queues and high facility utilizations, two runs were conducted. Run One used a constant interarrival time and an input rate of 1000 messages per hour for a three hour system run time. Facility utilization for both AUTODIN channels remained low while the main processor experienced approximately 60 percent utilization. However, the four fleet broadcast

channel utilizations were approximately 99 percent the first hour and remained at that level during the three hour period. Queue time increased rapidly but stayed within allowable limits for precedence processing and output transmission, as specified by Naval communications policy.

For the second run, an input of 1000 messages per hour was used for a five hour system run time. The results were similar to the first run with no new significant observations.

D. CONSTANT MESSAGE LENGTH RUNS

Message length was tested in four simulation runs of three hours duration each, with an input rate of 1,000 messages per hour, in order to ascertain its effect on the model. The results indicate a sensitive relationship between message length, average time a message waits in an output queue for processing, and the processing capabilities of the main processor (POUT) and fleet broadcast channels.

The fleet broadcast output capability is a constant based on 100 WPM radio teletype using six characters per word, i.e., an output rate of 600 characters per minute. The loading of the output channels is based on an empirical distribution derived from two days of actual data. Of the

four fleet broadcast channels, the lowest loading rate was six percent of the total output from POUT and the highest loading rate was nine percent, resulting in a 33 percent drop in loading rate from the highest to the lowest. Message length was varied from 1,000 to 2,500 characters per message in 500 character increments per simulation run. This was a 33 percent increase rate per run over the interval investigated. It should be noted that this was coincidental and not contrived to specifically fit the model.

Figure 8 is a plot of average time per transaction in an output queue versus message length for each fleet broadcast channel by hour. Observe that NMEE #2, the lowest input rate per channel, lags NMAA #2, the highest input rate per channel, by one cycle,[4] when measured by average time in queue. This lag is due to the relationship of input loading rate (a 33 percent difference) and the size of message. The total number of characters entering into NMEE #2 at 1,500 characters per message is approximately equal to the total number of characters entering NMAA #2 at 1,000 characters per message. This supports the intuition that as message length increases,

---

[4] One cycle corresponds to one increment of 500 characters per message in Figure 8.

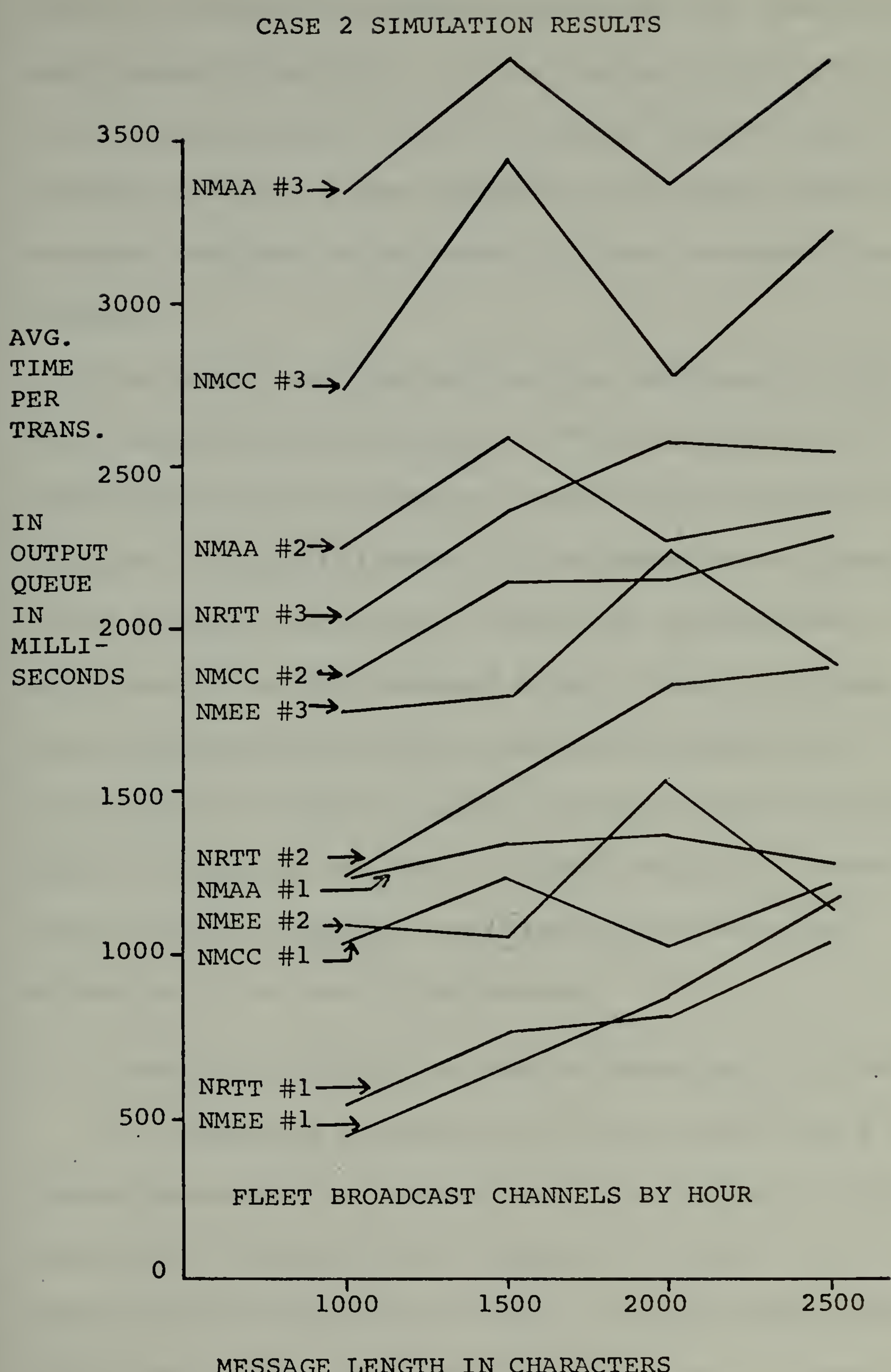

CASE 2 SIMULATION RESULTS
AVG. TIME PER TRANS. IN OUTPUT QUEUE IN MILLI-SECONDS
3500
3000
2500
2000
1500
1000
500
0
NMAA #3
NMCC #3
NMAA #2
NRTT #3
NMCC #2
NMEE #3
NRTT #2
NMAA #1
NMEE #2
NMCC #1
NRTT #1
NMEE #1
FLEET BROADCAST CHANNELS BY HOUR
1000
1500
2000
2500
MESSAGE LENGTH IN CHARACTERS

Figure 8

the total number of messages loaded into the fleet broadcast channels decreases. As the message length increases, the bottleneck shifts from each output channel queue to the main processor, thus decreasing the total number of messages available to be loaded in fleet broadcast queues per hour.

The above case demonstrates the usefulness of the model because the results give a dynamic quantitative relationship between message length, output channel percentages, loading and number of messages for the specific set of defined conditions. Additional quantitative relationships between message length, output channels, etc., can be developed by various data input combinations. Potentially, a family of relationships could be developed which will enable the user to answer several "If-Then" type questions regarding these parameters and their effects on total system performance.

E. SIMULATION VARYING THE RANDOM NUMBER SEED IN FUNCTION 3

In a FUNCTION statement the RN pair indicates a random number generation for execution of the function. The number immediately following RN is called the "seed." It is this number which determines the entry into the random number table contained in the IBM 360/GPSS system. In order to test the random number generation for GPSS, two simulation

runs were made changing the seed contained in the message length FUNCTION statement.

In the NAVCOMPARS, message length is critical due to its relation as throughput to the processing system. That is, the longer the message the longer it will take to process it completely through the processing and routing system. By changing the seed in determining message length, changes should occur in the output statistics of the program if random number generation is anything other than random.

The results of this model test showed absolutely no change in any of the simulation output statistics. Therefore, it is concluded that the point of entry into the random number tables will not have any effect on the final results of the simulation.

IV. POTENTIAL APPLICATIONS THROUGH MODEL EXPANSION AND CONCLUSIONS

To systematically expand upon a model it must possess the characteristic of "modularity," which means that modules or segments may be added in order to improve the ability to faithfully simulate the actual system. With this in mind, the NAVCOMPARS model was developed to be modular. The following examples indicate this feature and its capability.

A. POTENTIAL APPLICATION THROUGH MODEL EXPANSION

1. Auxillary Fleet Broadcast Channels for Output.

During the daily operation of NAVCOMPARS it is possible to have an increase of incoming traffic, destined to the fleet, such that the multichannel (MUX)/single channel fleet broadcast channels are overloaded. In that case auxillary channels of the MUX are activated until internal queues are cleared and the operation returns to a normal state, i.e., a handling time acceptable within Naval communication policy. In order to accomplish MUX auxilliary channel activation in the program, a TRANSFER statement must be added per channel activated, with the new distribution between the main and auxilliary channel branching to a QUEUE, SEIZE, DEPART, ADVANCE, RELEASE sequence for output processing delay time. For example,

fleet broadcast MUX channel NMAA auxilliary channel is NMBB; for NMCC the auxilliary is NMDD, etc. An assumption must be made with respect to the message split between the main and auxilliary channel.

2. Fleet Satellite Communications.

In the future, as NAVCOMPARS adds or deletes incoming and outgoing channels to the system, additions or deletions, may be attached to the model with minimum changes and programming. Of particular interest is the advent of Fleet Satellite Communications (FltSatComm). Outgoing channel speed will increase from 100 WPM teletype (TTY) to 1200 Baud. This significant change will eventually shift the output bottleneck from teletype output back to internal system processing.

To facilitate this change two items in the model's program must be added. First, to the variable card section include a new VARIABLE to compute the output channel speed. At 1200 Baud approximately 1500 WPM will pass over each additional FltSatComm channel. Therefore, the variable will equal (P3/150) X 1000. The variable will be measured in milliseconds. Secondly, the fleet broadcast section of the program must contain a cumulative TRANSFER statement to the branch that will add the ADVANCE

time onto the FltSatComm transaction.[5] This requires a change to the cumulative distribution of output channel type.[6]

Conversely, for those FltSatComm channels which are input to the NAVCOMPARS, the same input technique is used as with AUTODIN and other traffic type inputs. Here the variables of input speed and processing time must be considered in order to form a closed loop for the FltSatComm.

3. "Other" Inputs.

In the model those inputs other than AUTODIN were considered as "Other."[7] To further improve the model by the modularity technique, these "other" inputs need to be broken down and analyzed in terms of processing delay time incurred in reaching the CCM. These input processing times would include delays resulting from optical character readers, card readers, data speed readers, teletype and over-the-counter service. Each equipment processing time could be modularized as additions to the input channel

---

[5] See Appendix B

[6] See Appendix C

[7] See Figure 5

precedence queue.[8] Again using the GPSS sequence, QUEUE, SEIZE, DEPART, ADVANCE and RELEASE, delay time could be calculated and queue statistics generated for each type of input.

4. "Other" Output.

Non-fleet broadcast channels were considered in a single grouping as "Other." Since the application of this model involved output fleet broadcast channels only, any other traffic was not considered. However, another module could be added to the model by analyzing these "other" output processing times. These would include dedicated TTY circuits, electronic courier circuits, AUTODIN, and over-the-counter service, and could be added to the program after the fleet channel ADVANCE computations.

5. Main Processor (UNIVAC 70/45G) Model Simulation.

The final module, and possibly the largest is the main frame processor. As an aid to understanding the operation of the internal processing system, a model of the main processor could be developed. This sub-model of the system should involve software items such as: (1) precedence queueing processing; (2) distribution assignment; (3) distribution processing; (4) message entry, filing and

---

[8] Op.Cit.

retrieval; (5) support file maintenance; and (6) generation of daily reports.

The hardware aspect of the system could include timing analysis of video data terminals, paper tape reader, paper tape punch, line printers, disk storage units, mass storage units, and magnetic tape units.[9]

This proposed module would fit into the present model whose input would be received via the ACC or CCM and whose output would terminate in the fleet broadcast or non-fleet broadcast channels discussed in this section.

It should be noted that simulation need not replicate events in minute detail. Therefore, the model offers areas of expansion as separate studies into particular subsections of the entire Naval Communications Processing and Routing System.

B. SUMMARY

In developing the NAVCOMPARS model the major concern was to simulate functional relationships. Two days of data was used only to generate statistics in order to observe the operation of the model. The functional representation of the model is in no way constrained by use of this data. The model is flexible because either observed

---

[9] See Figure 2.

or theoretical data may be used to generate the empirical distributions that are the basis of the model's FUNCTION and VARIABLE statements.

This is a management tool of the "If-Then" type and, as such, is possibly the first of its kind for NAVCOMPARS. The observations made from actual simulation runs discussed in Section III indicates the power of this model to evaluate the many varying conditions which may occur at a NAVCOMPARS installation. The model considers fundamental parameters, such as number of messages, message length, precedence, processing times, and output transmissions times, and therefore is not dependent on the equipment currently used at NAVCOMPARS installations. However, as noted in this section, there exists potential for expansion which, when developed, will increase the usefullness of this model.

APPENDIX A
NAVCOMPARS MODEL: FLOW
DIAGRAM FOR GPSS PROGRAM

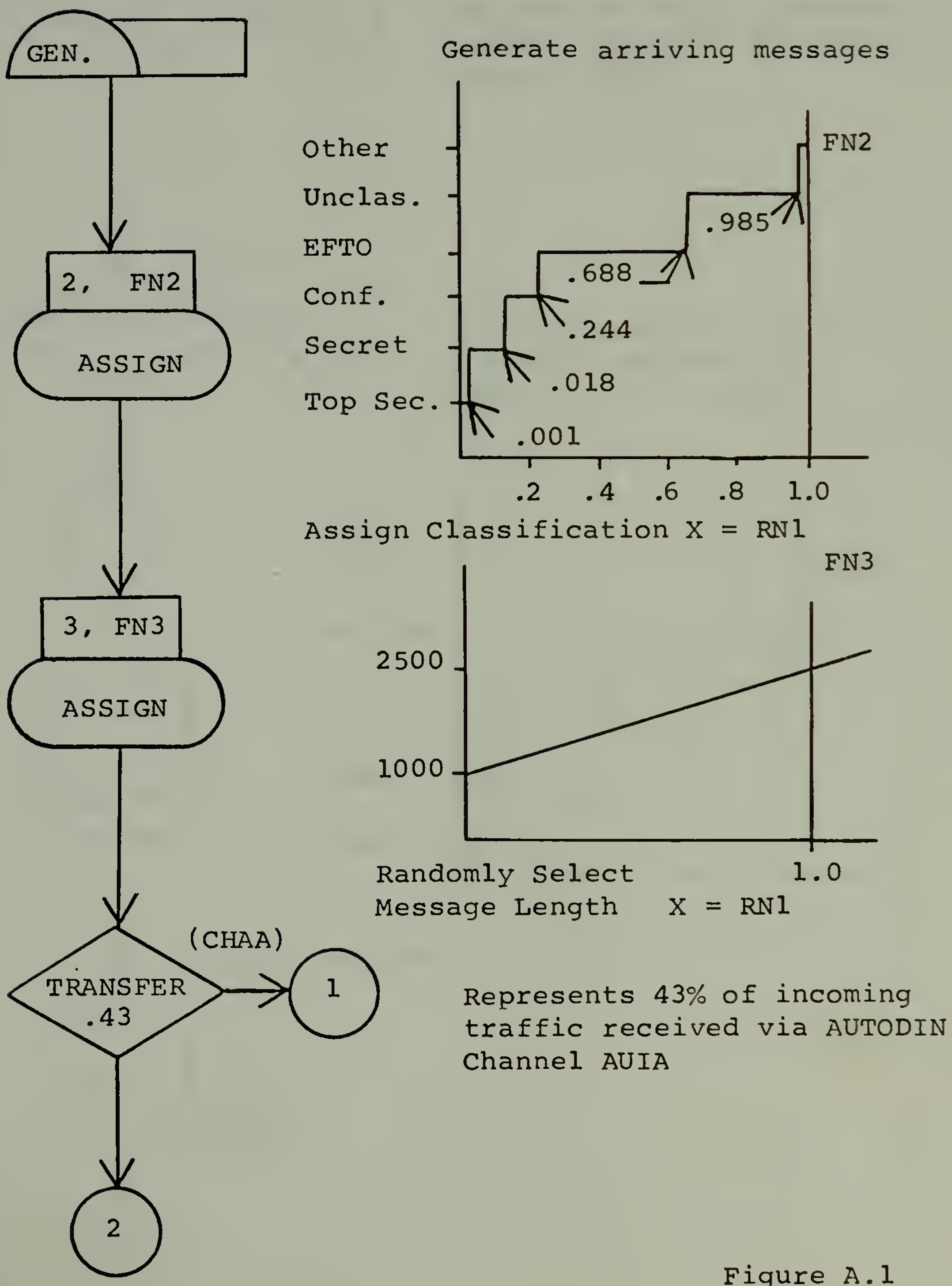
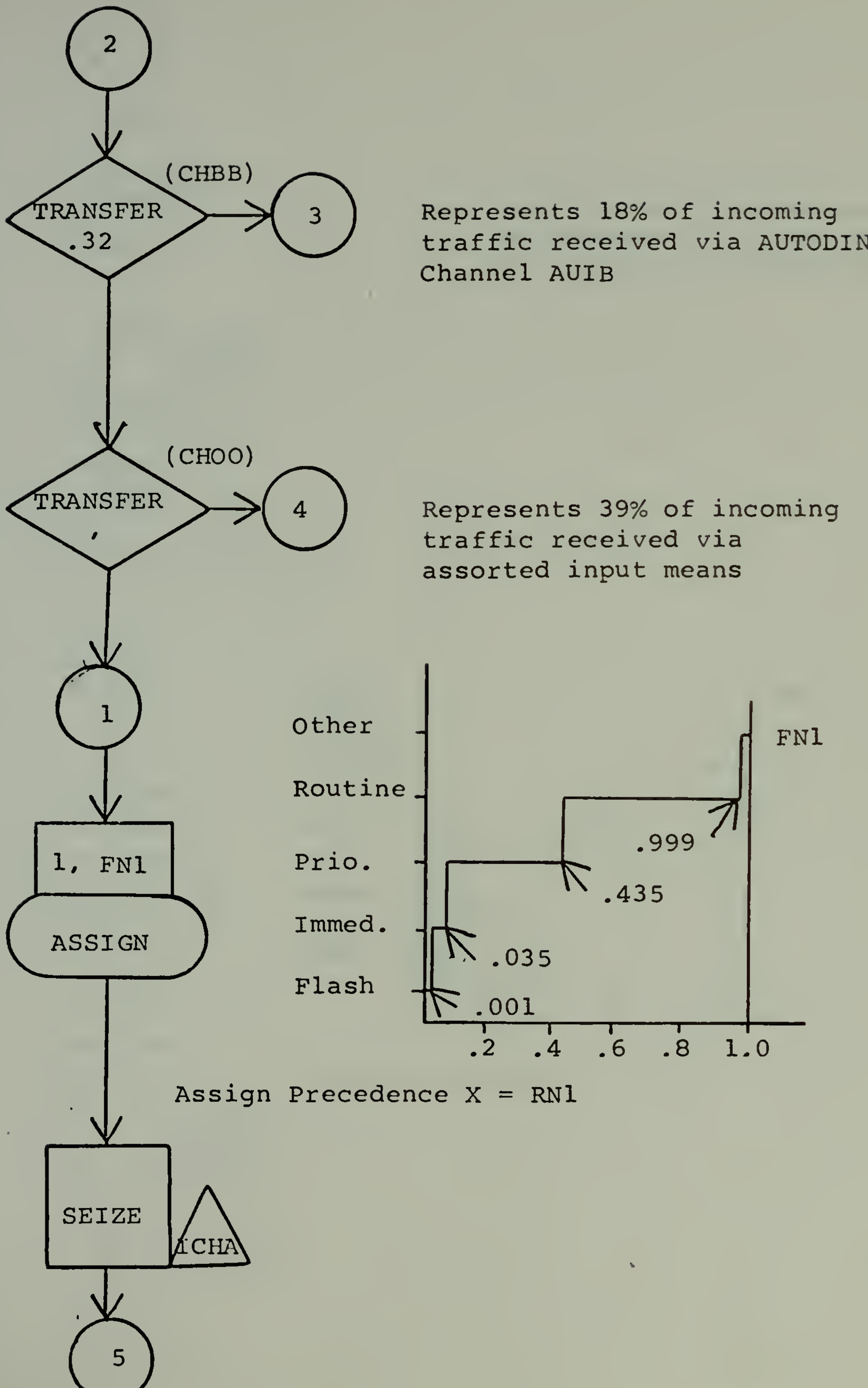
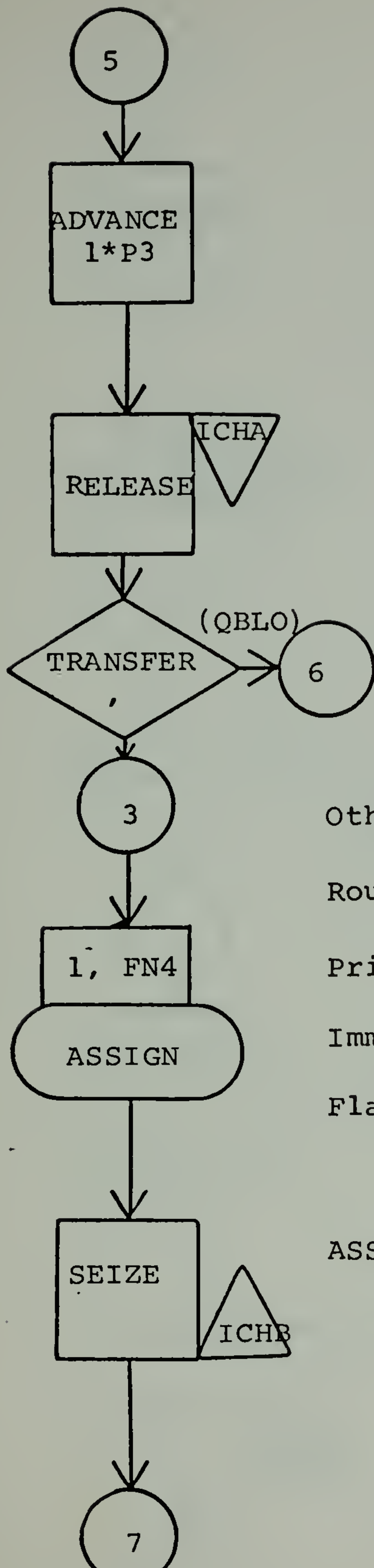
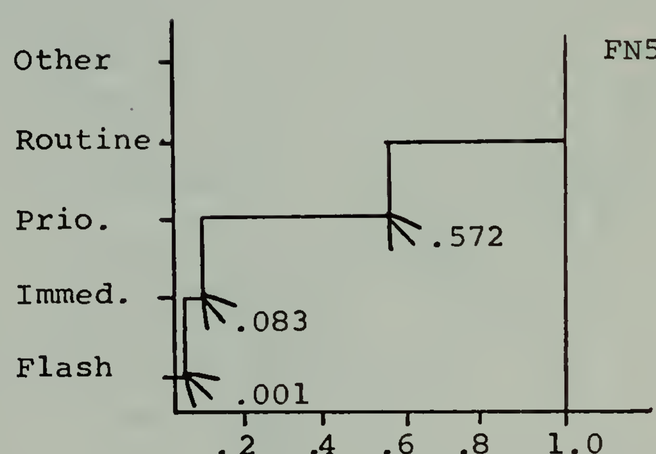


Figure A.1

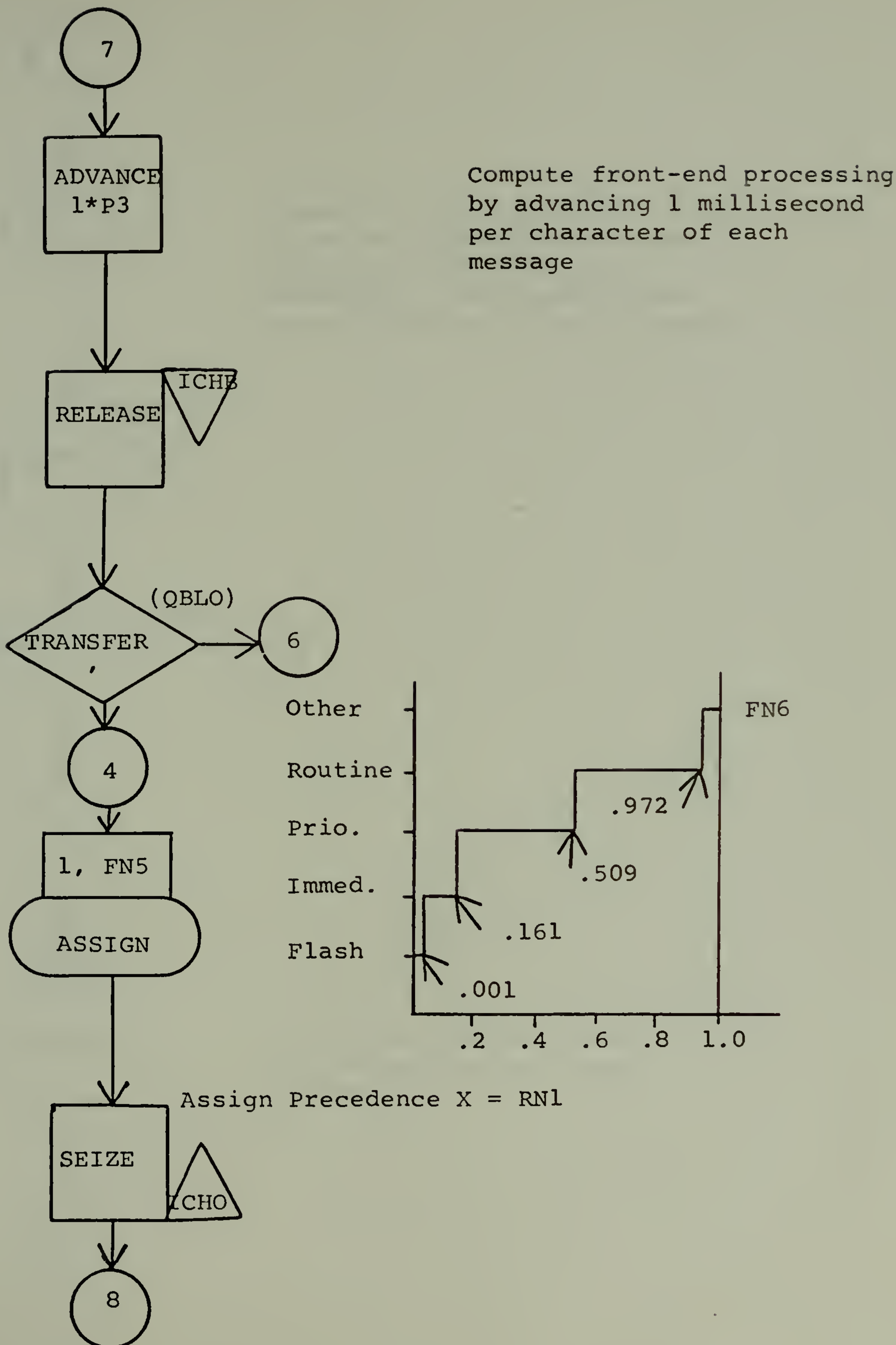

2
TRANSFER
.32
(CHBB)
3
Represents 18% of incoming traffic received via AUTODIN Channel AUIB
TRANSFER
,
(CHOO)
4
Represents 39% of incoming traffic received via assorted input means
1
1, FN1
ASSIGN
Other
Routine
Prio.
Immed.
Flash
FN1
.999
.435
.035
.001
.2
.4
.6
.8
1.0
Assign Precedence X = RN1
SEIZE
CHA
5

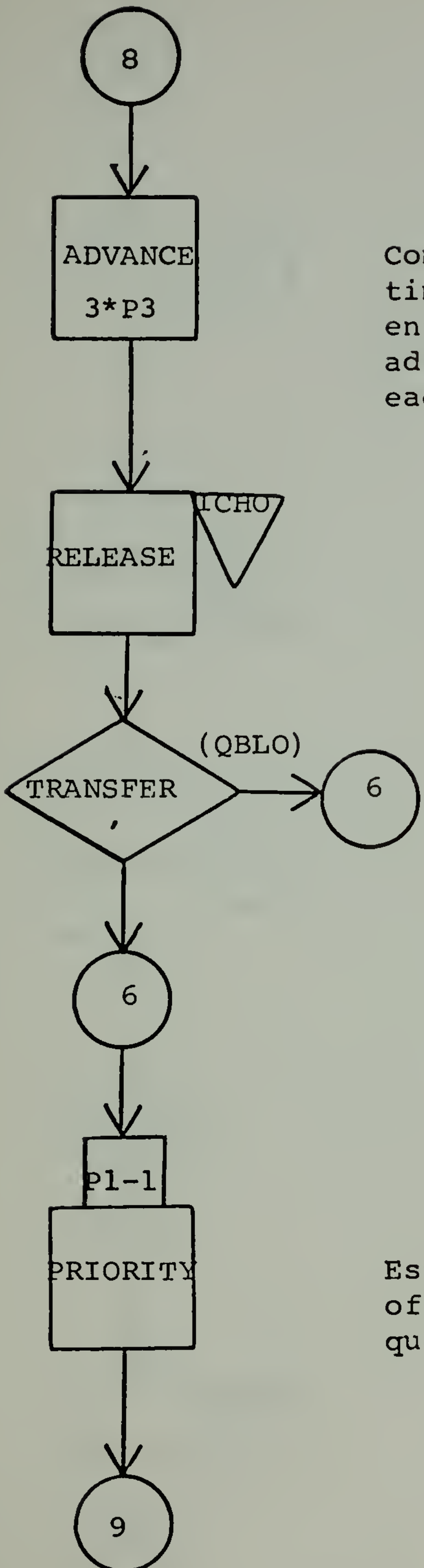


Compute front-end processing by advancing 1 millisecond per character of each message



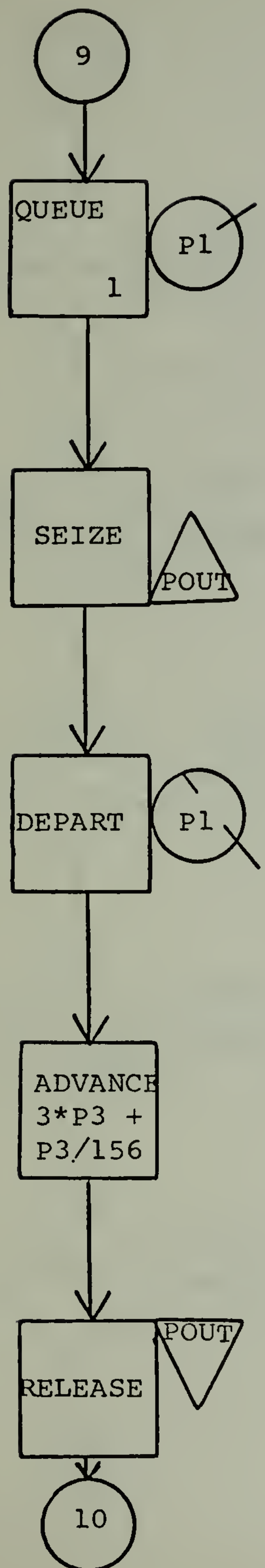
ASSIGN Precedence X = RN1


7
ADVANCE
1*P3
Compute front-end processing by advancing 1 millisecond per character of each message
RELEASE
ICHB
(QBLO)
TRANSFER
,
6
4
1, FN5
ASSIGN
Other
Routine
Prio.
Immed.
Flash
FN6
.972
.509
.161
.001
.2
.4
.6
.8
1.0
Assign Precedence X = RN1
SEIZE
ICHO
8

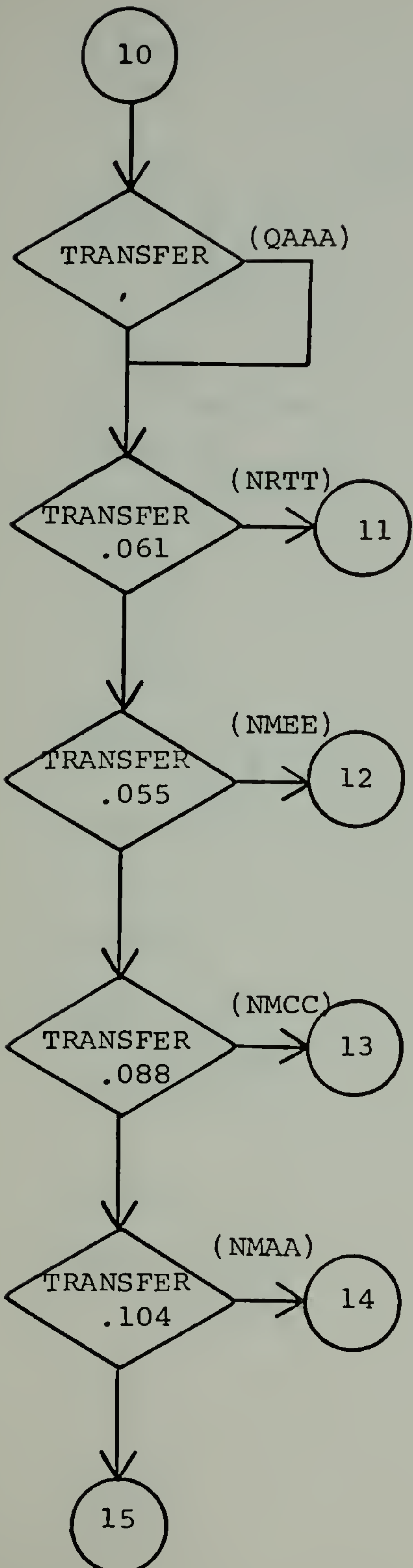


Compute message handling time for non-AUTODIN messages entering NAVCOMPARS by advancing 3 milliseconds per each character of the message

Establish message priority of precedence for proper queueing



Computation for systems
Main Frame (Univac 70/45G)
processing time per message



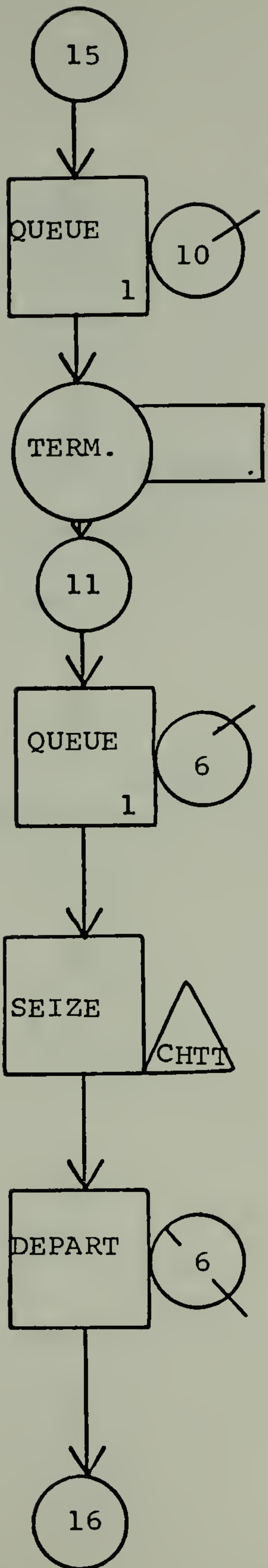
Transfer unconditionally to the Fleet Broadcast Output section

Transfer to Fleet Broadcast Channel NRTT

Transfer to Fleet Broadcast Channel NMEE

Transfer to Fleet Broadcast Channel NMCC

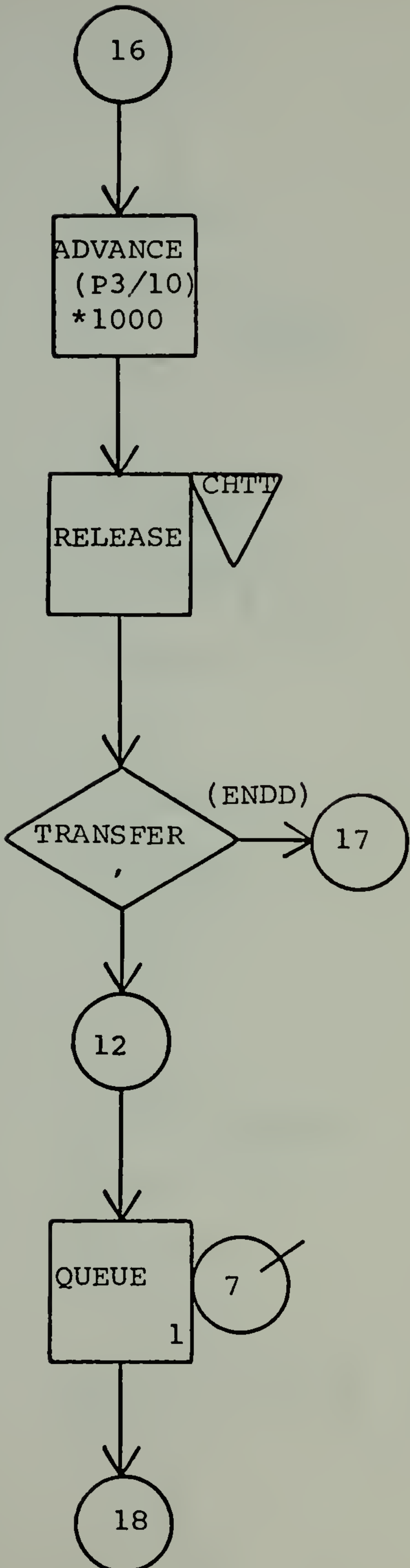
Transfer to Fleet Broadcast Channel NMAA



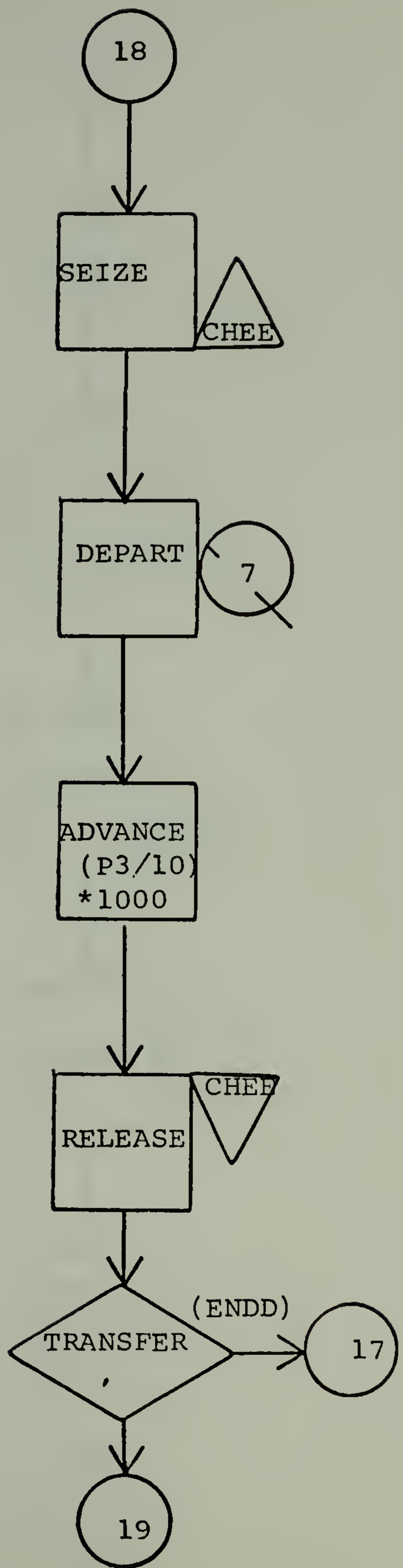
Queue DEAD for all other traffic going to output channel other than Fleet Broadcast

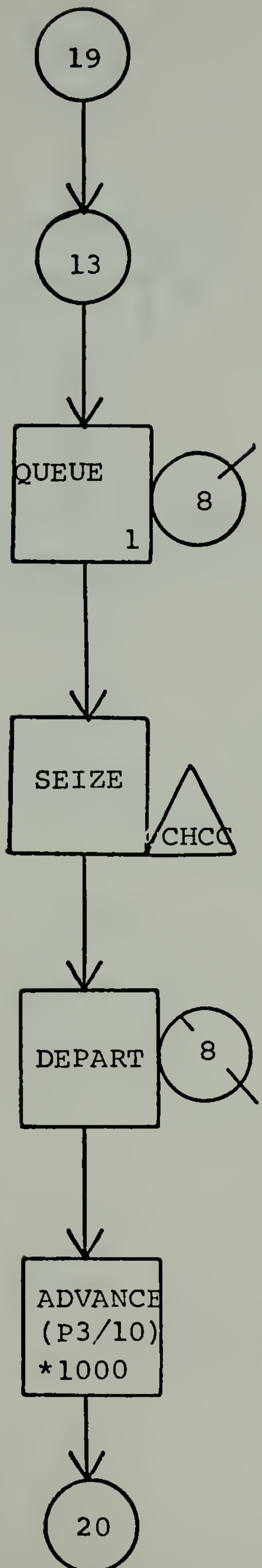
Termination of Queue 10

Output processing for Fleet Broadcast Channel NRTT

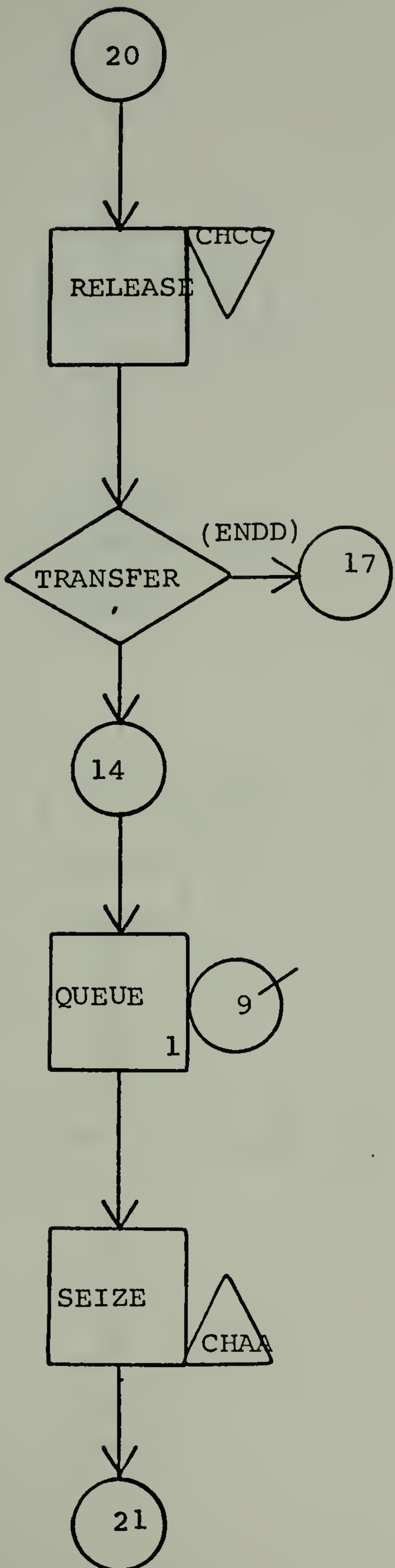


Output processing for
Fleet Broadcast Channel
NMEE

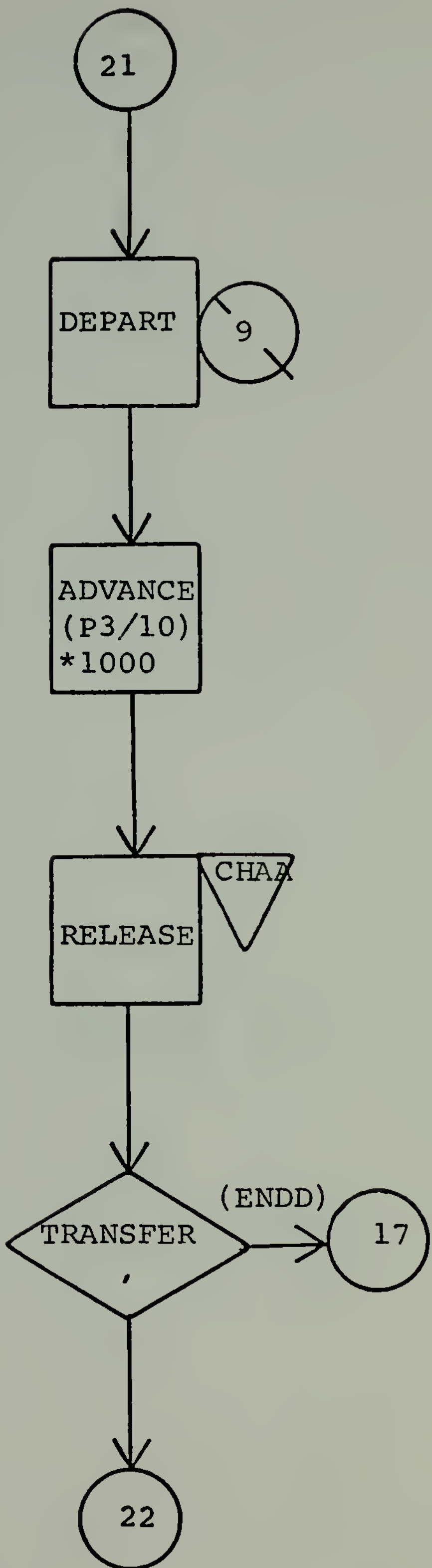

18
SEIZE
CHEE
DEPART
7
ADVANCE
(P3/10)
*1000
RELEASE
CHEE
TRANSFER
,
(ENDD)
17
19

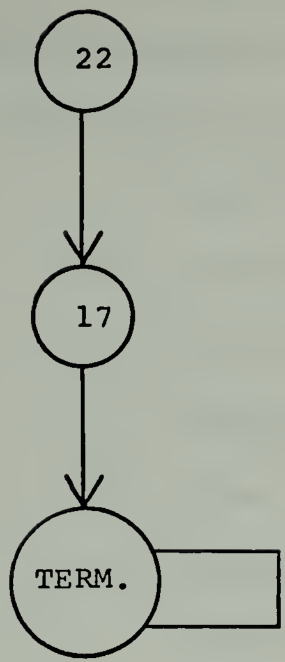


Output processing for
Fleet Broadcast Channel
NMCC

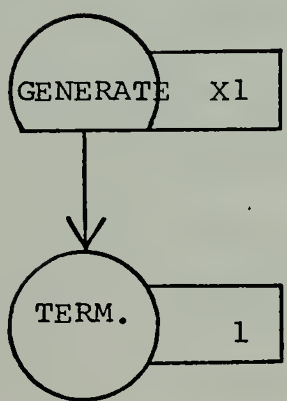


Output processing for
Fleet Broadcast Channel
NMAA


21
DEPART
9
ADVANCE
(P3/10)
*1000
RELEASE
CHAA
TRANSFER
,
(ENDD)
17
22



Terminate program



GENERATE: allow an expansion in the contents of the "Relative Clock" to equal 3600000 milliseconds, Note 1 clock unit equals 1 millisecond

Transactions flow into this TERMINATE clock one at a time decrementing the counter each time by one. When the counter equals zero the simulation stops for that specified time period

FLOWCHART SYMBOL DEFINITIONS

FUNCTION Statement Definitions:

FN1= AUTODIN Channel AUIA precedence function

1 = Flash Precedence

2 = Operational Immediate Precedence

3 = Priority Precedence

4 = Routine Precedence

5 = Other, i.e. those incoming messages which could not be automatically identified with respect to precedence.

FN2= Classification Function

1 = Top Secret

2 = Secret

3 = Confidential

4 = Encrypted for Transmission Only (EFTO)

5 = Unclassified

6 = Other, i.e., those incoming messages which could not be automatically identified with respect to classification.

FN3= Random generation for determination of message length in characters.

FN4= AUTODIN Channel AUIB precedence function, the same number assignment as FN1.

FN5= All other traffic function for incoming messages by precedence, the same number assignment as FN1.

PARAMETERS:

1 = Precedence of messages by incoming channel

2 = Classification of message

3 = Message length in characters

4 = Not used

5 = Fleet broadcast output by channel

FACILITY SYMBOL DEFINITION:

ICHA = Incoming AUTODIN Channel 'A' (AUIA)

ICHB = Incoming AUTODIN Channel 'B' (AUIB)

ICHO = All other traffic incoming to NAVCOMPARS

POUT = Fleet broadcast channels out

CHAA = Fleet broadcast channel NMAA

CHCC = Fleet broadcast channel NMCC

CHEE = Fleet broadcast channel NMEE

CHTT = Fleet broadcast channel NRTT

PROGRAM SYMBOL DEFINITIONS:

CHAA = AUTODIN Channel 'A' front-end processing

CHBB = AUTODIN Channel 'B' front-end processing

CHOO = Other incoming traffic processing into the system

QBLO = Main frame (UNIVAC 70/45G) processing time

QAAA = Computation for output transmission time over fleet broadcast

NRTT = Fleet broadcast channel NRTT output processing

NMEE = Fleet broadcast channel NMEE output processing

NMCC = Fleet broadcast channel NMCC output processing

NMAA = Fleet broadcast channel NMAA output processing

GENERAL DEFINITIONS:

RN1 = RN is for Random Number Generation used in GPSS/360 and is calculated from a set of eight base numbers called SEEDS. The user can specify any one of these seeds RN1-RN8.

FN = Designator used for FUNCTION, which is basically a numerical value that is computed from a rule defined by the user of either a discrete or continuour function.

APPENDIX B

NAVCOMPARS MODEL
GPSS PROGRAM

```
          REALLOCATE XAC,6000,COM,400000
          SIMULATE
          INITIAL    X1,3600000
*
*         DEFINE FUNCTIONS
*
     1    FUNCTION   RN1,D5                     CHANNEL 'A' PRECEDENCE
.001,5/.035,4/.435,3/.999,2/1.0,1
     2    FUNCTION   RN1,D6                     CLASSIFICATION
.001,1/.018,2/.244,3/.688,4/.985,5/1.0,6
     3    FUNCTION   RN1,C2                     MSG LENGTH CHAR
.000,1000/1.0,2500
     4    FUNCTION   RN1,D4                     CHANNEL B PRECEDENCE
.001,5/.083,4/.572,3/1.0,2
     5    FUNCTION   RN1,D5                     OTHER CHANNEL INC. REC.
.001,5/.061,4/.509,3/.972,2/1.0,1
*
*         DEFINE VARIABLES
*
    CA    VARIABLE   FN1                        CHANNEL A PRECEDENCE
    CL    VARIABLE   FN2                        CLASSIFICATION
    MS    VARIABLE   FN3                        MSG LENGTH CHAR
    CB    VARIABLE   FN4                        CHANNEL B PRECEDENCE
    CH    VARIABLE   FN5                        OTHER CHANNEL PRECEDENCE
    HR    VARIABLE   1*P3                       FRONT-END PROC COMPUTION
    OO    VARIABLE   3*P3                       OTHER CHAN F-E PROC
    PR    VARIABLE   P1-1                       PRIORITY
    HT    VARIABLE   3*P3+P3/156                3 MSEC EXEC PER CHAR MCPU
    OT    VARIABLE   (P3/10)*1000               XMIT OUT COMPUTATION
*
*         MODEL PROGRAM
*
 GEN      GENERATE   3596
          ASSIGN     2,V$CL                     ASSIGN CLASSIFICATION
          ASSIGN     3,V$MS                     ASSIGN MESSAGE LENGTH
```

```
         TRANSFER    .43,NTRS,CHAA                CHANNEL 'A' INPUT
NTRS     TRANSFER    .32,QOUT,CHBB                CHANNEL 'B' INPUT
QOUT     TRANSFER    ,CHOO                        MISC. INCOMING MESSAGES
CHAA     ASSIGN      1,V$CA                       CH. A FRONT-END PROC.
         SEIZE       ICHA
         ADVANCE     V$HR
         RELEASE     ICHA
         TRANSFER    ,QBLO
CHBB     ASSIGN      1,V$CB                       CH. B. FRONT-END PROC.
         SEIZE       ICHB
         ADVANCE     V$HR
         RELEASE     ICHB

         TRANSFER    ,QBLO
CHOO     ASSIGN      1,V$CH                       OTHER CH. FRONT-END PROC
         SEIZE       ICHO
         ADVANCE     V$OO
         RELEASE     ICHO
         TRANSFER    ,QBLO
QBLC     PRIORITY    V$PR                         MAIN CPU PROC.
         QUEUE       P1,1
         SEIZE       POUT
         DEPART      P1
         ADVANCE     V$HT
         RELEASE     POUT
         TRANSFER    ,QAAA                        FLT. BCST. OUT
QAAA     TRANSFER    .061,BCTE,NRTT
BCTE     TRANSFER    .055,BCTC,NMEE
BCTC     TRANSFER    .088,BCTA,NMCC
BCTA     TRANSFER    .104,DEAD,NMAA
DEAD     QUEUE       10,1
         TERMINATE
```

```
NRTT    QUEUE       6,1                 BCST. CH.  NRTT
        SEIZE       CHTT
        DEPART      6
        ADVANCE     V$OT
        RELEASE     CHTT
        TRANSFER    ,ENDD
NMEE    QUEUE       7,1                 BCST. CH.  NMEE
        SEIZE       CHEE
        DEPART      7
        ADVANCE     V$OT
        RELEASE     CHEE
        TRANSFER    ,ENDD
NMCC    QUEUE       8,1                 BCST. CH.  NMCC
        SEIZE       CHCC
        DEPART      8
        ADVANCE     V$OT
        RELEASE     CHCC
        TRANSFER    ,ENDD
NMAA    QUEUE       9,1                 BCST. CH.  NMAA
        SEIZE       CHAA
        DEPART      9
        ADVANCE     V$OT
        RELEASE     CHAA
        TRANSFER    ,ENDD
ENDD    TERMINATE
        GENERATE    X1
        TERMINATE   1
        START       1
*
*       DATA REQUIREMENTS
*
        END
```

```
          INITIAL        X1,3600000
*
*         DEFINE FUNCTIONS
*
 1        FUNCTION       RN1   D5
.001        5              .035       4          .435      3
.999        2             1.0         1
 2        FUNCTION       RN1   D6
.001        1              .018       2          .244      3
.688        4              .985       5         1.0        6
 3        FUNCTION       RN3   C2
.000        1000          1.0         2500
 4        FUNCTION       RN1   D4
.001        5              .083       4          .572      3
1.0         2
 5        FUNCTION       RN1   D5
.001        5              .061       4          .509      3
.972        2             1.0         1
*
*         DEFINE VARIABLES
*
 1        VARIABLE       FN1
 2        VARIABLE       FN2
 3        VARIABLE       FN3
 4        VARIABLE       FN4
 5        VARIABLE       FN5
 6        VARIABLE       1*P3
 7        VARIABLE       3*P3
 8        VARIABLE       P1-1
 9        VARIABLE       3*P3+P3/156
 10       VARIABLE       (P3/10)*1000
*
*         MODEL PROGRAM
*
 1        GENERATE       3596
 2        ASSIGN         2      V2
 3        ASSIGN         3      V3
 4        TRANSFER       .430   4         7
 5        TRANSFER       .320   6         12
 6        TRANSFER              17
 7        ASSIGN         1      V1
 8        SEIZE          1
 9        ADVANCE        V7
 10       RELEASE        1
 11       TRANSFER              22
 12       ASSIGN         1      V5
 13       SEIZE          2
 14       ADVANCE        V7
 15       RELEASE        2
 16       TRANSFER              22
 17       ASSIGN         1      V6
```

```
18      SEIZE       3
19      ADVANCE     V8
20      RELEASE     3
21      TRANSFER            22
22      PRIORITY    V9
23      QUEUE       P1      1
24      SEIZE       4
25      DEPART      P1
26      ADVANCE     V10
27      RELEASE     4
28      TRANSFER            29
29      TRANSFER    .061    30      35
30      TRANSFER    .055    31      41
31      TRANSFER    .088    32      47
32      TRANSFER    .104    33      53
33      QUEUE       10      1
34      TERMINATE
35      QUEUE       6       1
36      SEIZE       5
37      DEPART      6
38      ADVANCE     V11
39      RELEASE     5
40      TRANSFER            59
41      QUEUE       7       1
42      SEIZE       6
43      DEPART      7
44      ADVANCE     V11
45      RELEASE     6
46      TRANSFER            59
47      QUEUE       8       1
48      SEIZE       7
49      DEPART      8
50      ADVANCE     V11
51      RELEASE     7
52      TRANSFER            59
53      QUEUE       9       1
54      SEIZE       8
55      DEPART      9
56      ADVANCE     V11
57      RELEASE     8
58      TRANSFER            59
59      TERMINATE
60      GENERATE    X1
61      TERMINATE   1
        START       1
```

APPENDIX C

NAVCOMPARS MODEL STATISTICAL DEVELOPMENT

INCOMING TRAFFIC STATISTICAL PRESENTATION

In order to exercise the model to ascertain its useability, statistics were generated from two separate days activities at NAVCOMPARS Norfolk, Va. While only two days data points were used to test the model's validity, an assumption is warranted to refine the output, increase the number of data points used as input.

Figure C.1 shows the total incoming traffic received by precedence over a two-day period. Figure C.2 and C.3 displays the AUTODIN input over two days. Function one (FN1) and function five (FN5) are cumulative distributions of the arithmetic means of two days input via AUTODIN channels AUIA and AUIB respectively, see Appendix A. Function six (FN6) is a cumulative distribution by precedence of all other incoming traffic determined by the difference of AUTODIN input and the total traffic received over the two day period, see Appendix A.

NAVCOMPARS TOTAL MESSAGES

RECEIVED BY PRECEDENCE

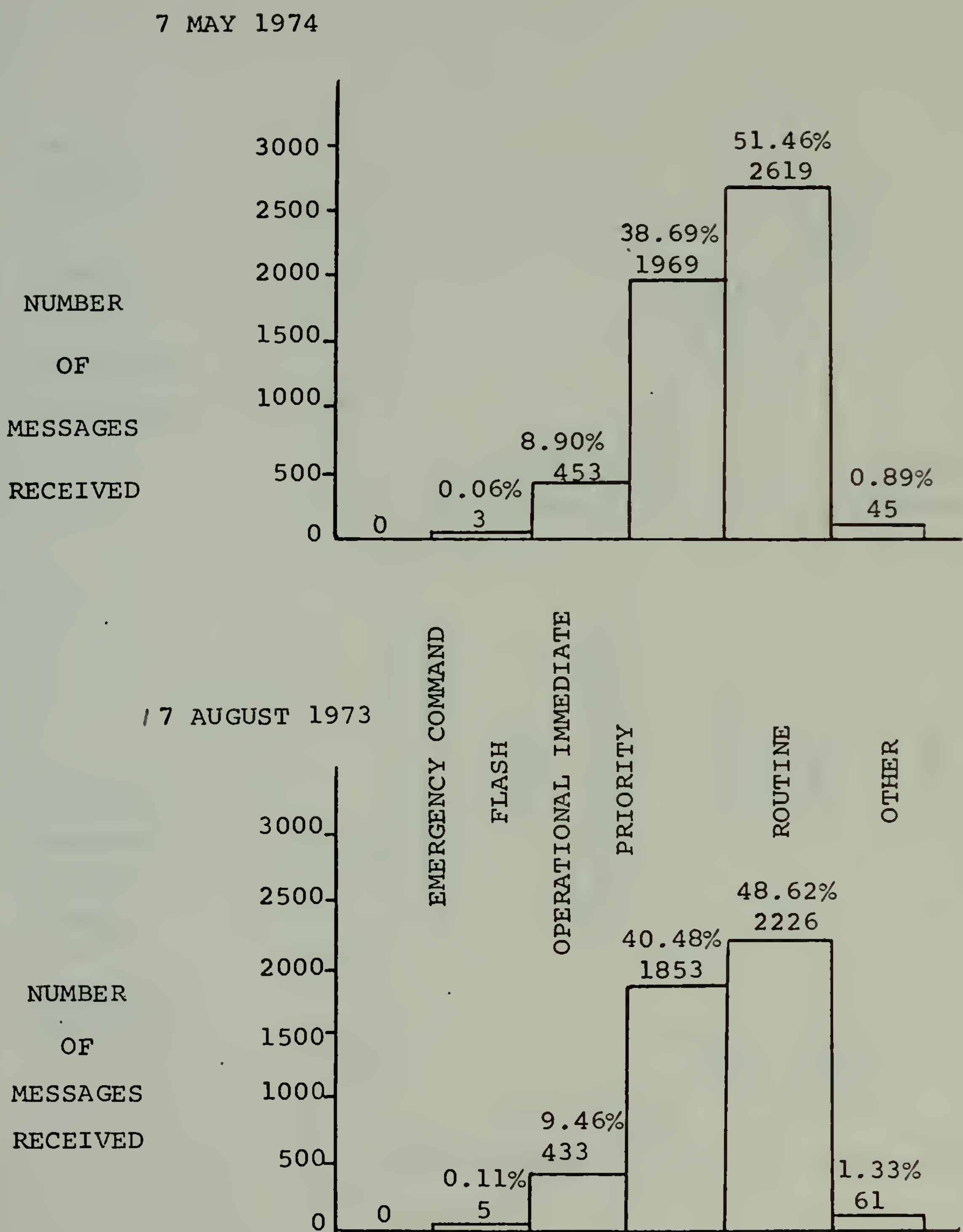


Figure C.1

MESSAGES RECEIVED

VIA AUTODIN

7 MAY 1974

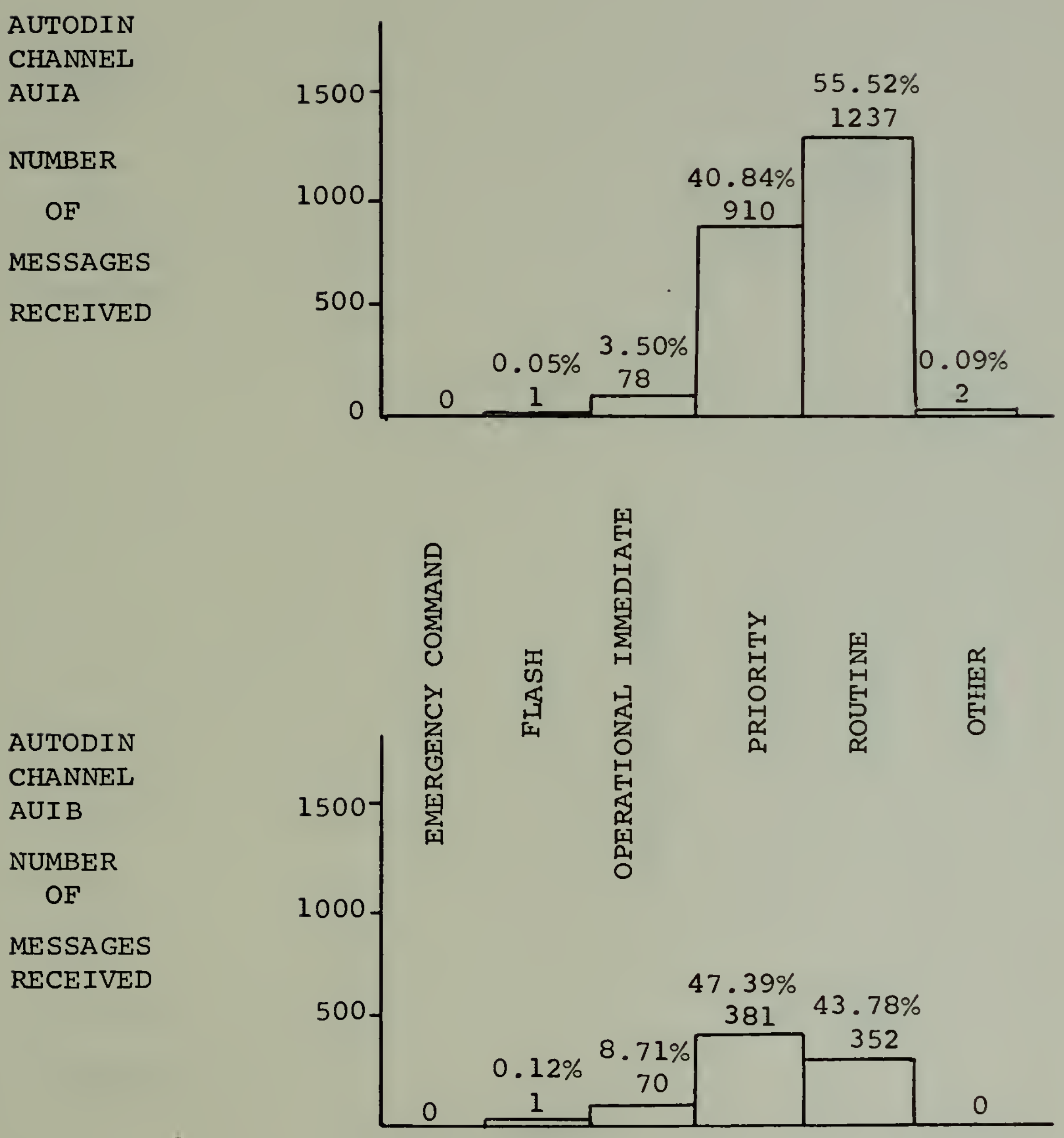


Figure C.2

MESSAGES RECEIVED

VIA AUTODIN

17 AUGUST 1973

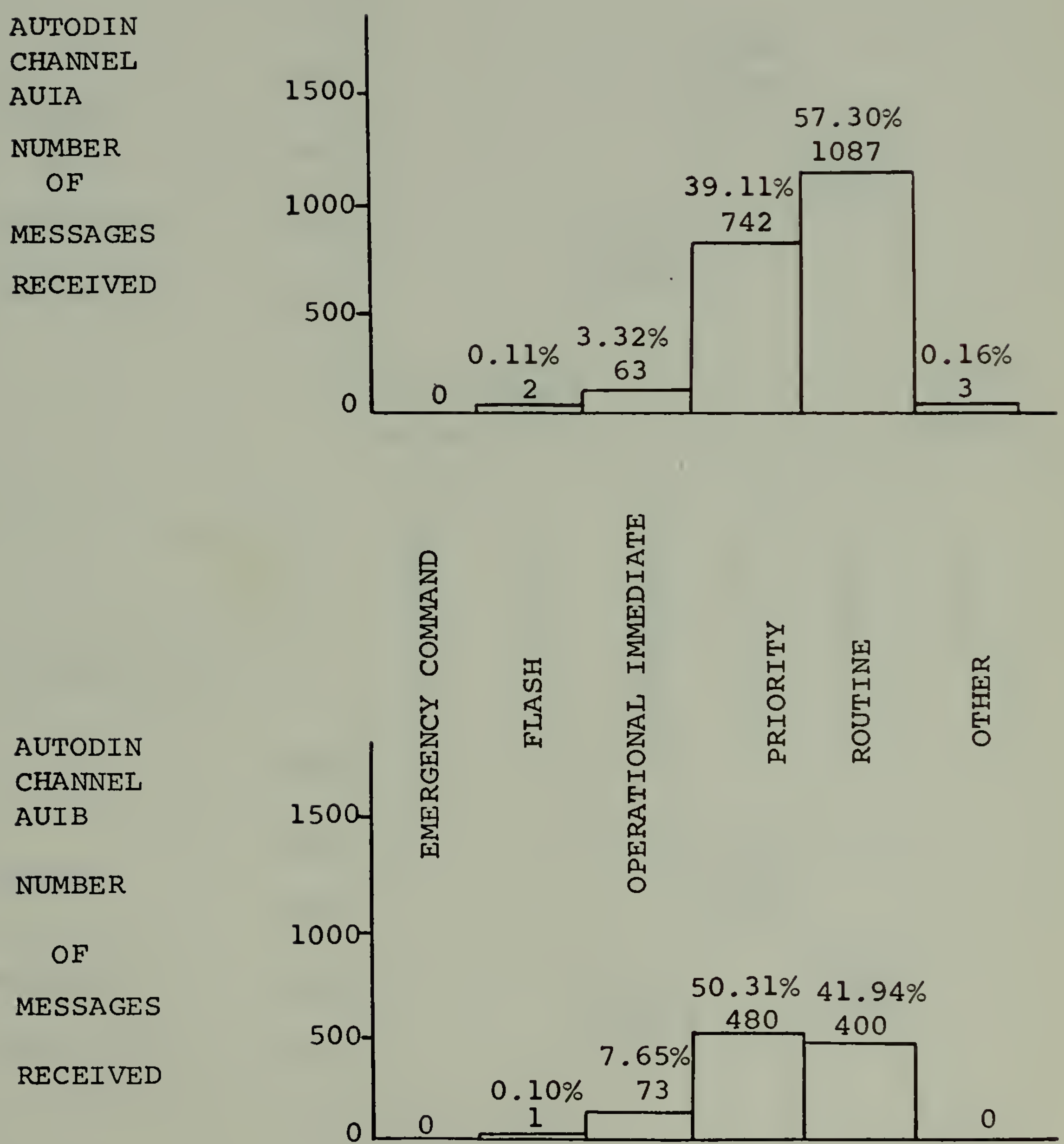


Figure C.3

NAVCOMPARS TOTAL MESSAGES

RECEIVED BY CLASSIFICATION

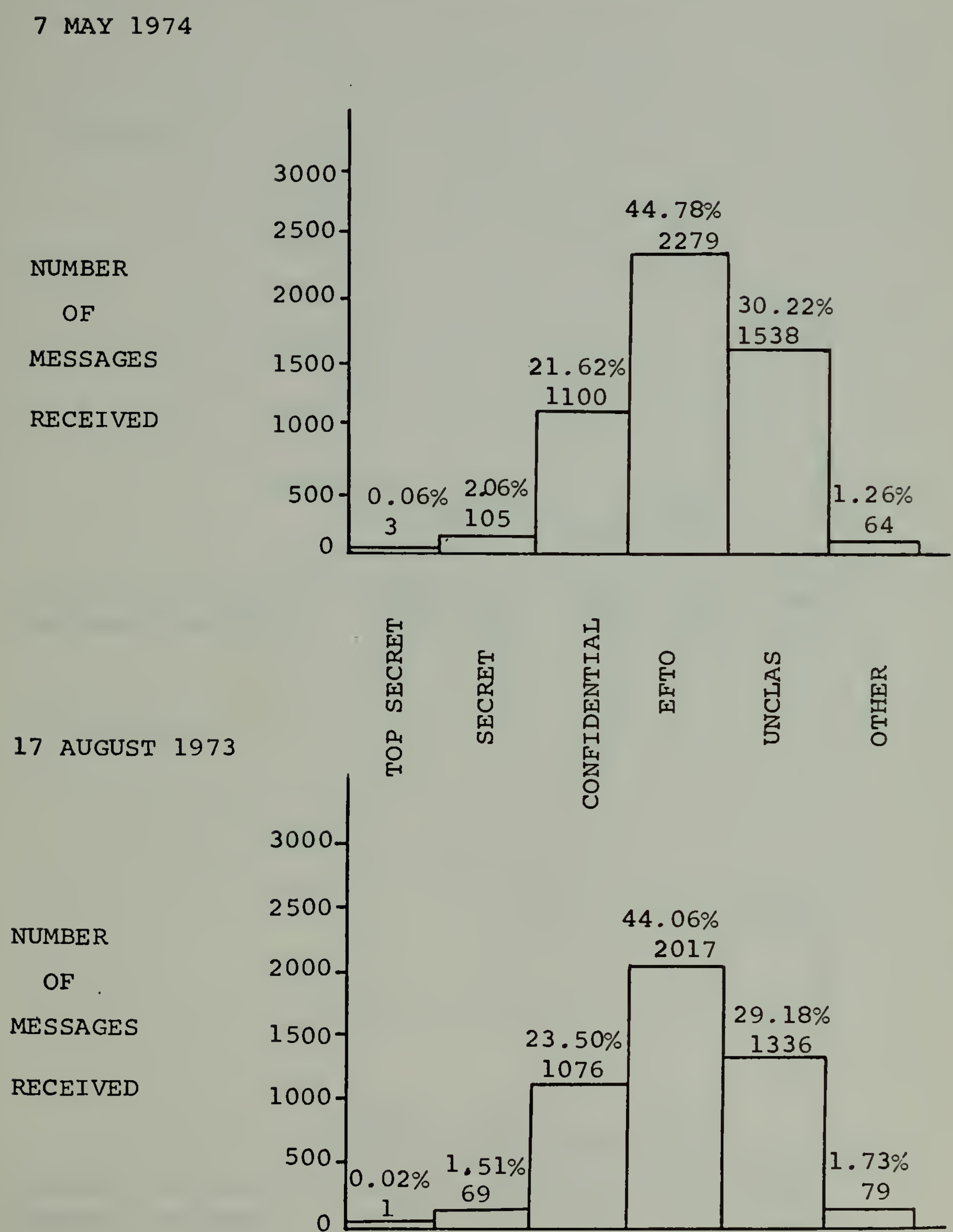
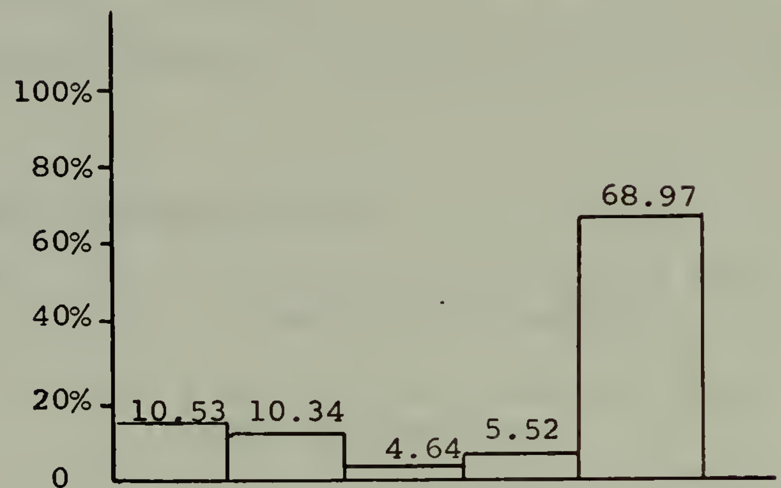


Figure C.4

FLEET BROADCAST OUTPUT CHANNELS

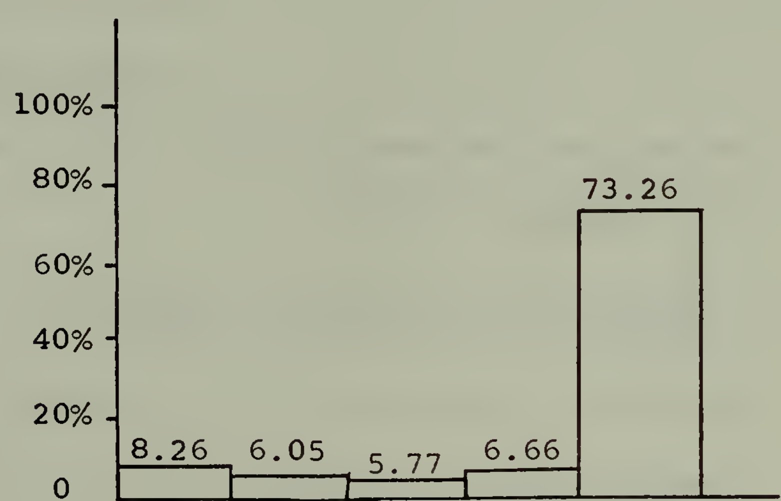
(By Percent of Messages per Channel)

7 MAY 1974



CHANNEL DESIGNATOR NMAA NMCC NMEE NRTT OTHER
MESSAGES XMITTED (536) (526) (236) (281) (3510)

17 AUGUST 1973



CHANNEL DESIGNATOR NMAA NMCC NMEE NRTT OTHER
MESSAGES XMITTED (378) (277) (264) (305) (3354)

Figure C.5

MAIN FRAME (UNIVAC 70/45G)

PROCESSING TIME COMPUTATION

The Main Frame processing time is the combination of the main computer (UNIVAC 70/45G) processing time plus the transfer rate from disk storage, i.e., the storage area to which an incoming message is routed via the ACC (UNIVAC 1600).

<u>Main Computer Processing Time</u>:

Assume: (a) 400 instructions required per character throughput

(a) x (b)

(b) 8 microseconds execution time per instruction

Therefore 3.2 milliseconds is required per character throughput. However 3 milliseconds was used in the GPSS program (Variable HT) due to the requirement of GPSS to use integers as variables.

<u>Disk Transfer Time</u>:

Assume: (a) 156,000 characters per second transfer rate from disk to main processor

Therefore $\left(\frac{\text{156000 characters per second}}{\text{1000 milliseconds per second}}\right)$ equals 156 characters transferred per millisecond to the main processor, thus the relation $\frac{\text{message character length}}{\text{156 characters/msecond}}$ equals the transfer time in milliseconds.

Parameter three (P3) in the GPSS program equals the incoming message length, therefore total processing time is equal to: (3 X P3) + (P3/156) {Variable HT} .

computer processing time

[illegible] xfer time

FLEET BROADCAST OUTPUT

CHANNEL TRANSMIT COMPUTATION

Known: (a) Transmit speed of fleet broadcast teletypewriter = 100 words per minute.

Assume: (a) Six characters per word as average

Therefore 600 characters per minute

Then 600 characters per minute ÷ 60 seconds per minute = 10 characters per second

Parameter 3 (P3) = message length in characters

$$\text{Then } \frac{P3}{10 \text{ characters per second}} = \text{seconds per message}$$

transmission time X 1000 milliseconds per second = transmission time in milliseconds per message.

Therefore Variable OT in GPSS program equals

$$\frac{(P3)}{(10)} \times 1000$$

APPENDIX D

GPSS GENERATED STATISTICS

GPSS STATISTICAL PRINTOUT DISCUSSION:

On the first line of a GPSS printout there appears the "Relative Clock" and "Absolute Clock" values. The Relative Clock measures simulated time since the model was last CLEARED. If no RESET cards have been used, the Absolute Clock will equal the Relative Clock and thus provide no additional information. In this model one clock unit equals one millisecond.

The "Block Count" information shows a running account of transaction movements in total, and the number of transactions remaining in a block upon conclusion of the simulated time, denoted "Current". Block numbers correspond to the compiled program.[10] See Figure D.1.

GPSS NAVCOMPARS MODEL PRINTOUT TERMS:

ICHA = Incoming facility channel 'A', which accounts for 43% of all incoming traffic in this model.

ICHB = Incoming facility channel 'B', which accounts for 18% of all incoming traffic in this model.

---

[10] See Appendix B.

ICHO = Incoming facility of various inputs into the NAVCOMPARS, which accounts for 39% of all incoming traffic in this model.

CHTT = Outgoing facility fleet broadcast channel NRTT which accounts for 6.1% of all outgoing traffic.

CHEE = Outgoing facility fleet broadcast channel NMEE which accounts for 5.2% of all outgoing traffic.

CHCC = Outgoing facility fleet broadcast channel NMCC which accounts for 8.3% of all outgoing traffic.

CHAA = Outgoing facility fleet broadcast channel NMAA which accounts for 9.5% of all outgoing traffic.

Facility 6 = Fleet broadcast channel NRTT

Facility 7 = Fleet broadcast channel NMEE

Facility 8 = Fleet broadcast channel NMCC

Facility 9 = Fleet broadcast channel NMAA

Facility 10= Other means of traffic exiting NAVCOMPARS not considered by this model.

Queue 1 = Those transactions whose precedence could not automatically be identified and thus was not considered in this model.

Queue 2 = Routine precedence traffic

Queue 3 = Priority precedence traffic

Queue 4 = Operational immediate precedence traffic

Queue 5 = Flash precedence traffic

Queue 6 = Fleet broadcast channel NRTT

Queue 7 = Fleet broadcast channel NMEE

Queue 8 = Fleet broadcast channel NMCC

Queue 9 = Fleet broadcast channel NMAA

Queue 10= Other output channels, not considered in this model.

```
1RELATIVE CLOCK       3600000  ABSOLUTE CLOCK        3600000
 BLOCK COUNTS
 BLOCK CURRENT       TOTAL     BLOCK CURRENT      TOTAL     BLOCK CURRENT      TOTAL     BLOCK CURRENT      TOTAL     BLOCK CURRENT      TOTAL
     1       0         249        11       0         98        21       0         97        31       0        220        41       2         15
     2       0         249        12       0         54        22       0        249        32       0        206        42       0         13
     3       0         249        13       0         54        23       0        249        33       0        185        43       0         13
     4       0         249        14       0         54        24       0        249        34       0        185        44       1         13
     5       0         151        15       0         54        25       0        249        35       1         14        45       0         12
     6       0          97        16       0         54        26       0        249        36       0         13        46       0         12
     7       0          98        17       0         97        27       0        249        37       0         13        47       2         14
     8       0          98        18       0         97        28       0        249        38       1         13        48       0         12
     9       0          98        19       0         97        29       0        249        39       0         12        49       0         12
    10       0          98        20       0         97        30       0        235        40       0         12        50       1         12
 BLOCK CURRENT       TOTAL     BLOCK CURRENT      TOTAL     BLOCK CURRENT      TOTAL     BLOCK CURRENT      TOTAL     BLOCK CURRENT      TOTAL
    51       0          11        61       0          1
    52       0          11
    53       5          21
    54       0          16
    55       0          16
    56       1          16
    57       0          15
    58       0          15
    59       0          50
    60       0           1


 FACILITY         AVERAGE           NUMBER        AVERAGE          SEIZING    PREEMPTING
               UTILIZATION         ENTRIES       TIME/TRAN        TRANS. NO.  TRANS. NO.
     ICHA          .049                 98        1813.856
     ICHB          .025                 54        1672.703
     ICHC          .144                 97        5354.535
     PCUT          .368                249        5326.664
     CHTT          .686                 13      189977.562           15
     CHEE          .616                 13      170624.375           11
     CHCC          .547                 12      164271.750           16
     CHAA          .772                 16      173733.625            5


 CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)
 SAVEVALUE  NR,       VALUE        NR,       VALUE        NR,       VALUE        NR,       VALUE        NR,       VALUE
               1     3600000


 QUEUE        MAXIMUM      AVERAGE      TOTAL       ZERO      PERCENT       AVERAGE       $AVERAGE       TABLE     CURRENT
             CONTENTS     CONTENTS     ENTRIES     ENTRIES     ZEROS      TIME/TRANS    TIME/TRANS     NUMBER    CONTENTS
     1              1        .000           8           8      100.0          .000          .000
     2              1        .000         125         125      100.0          .000          .000
     3              1        .000         104         104      100.0          .000          .000
     4              1        .000          12          12      100.0          .000          .000
     6              2        .529          14           6       42.8     136185.812    238325.250                    1
     7              2        .330          15           8       53.3      79320.812    169973.250                    2
     8              3        .523          14           4       28.5     134501.812    188302.562                    2
     9              6       2.742          21           1        4.7     470113.375    493619.062                    5
    10            185      97.063         185                     .0    1888807.000   1888807.000                  185
  $AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES
*
*         DATA REQUIREMENTS
*
 1        GENERATE      12034
          START         1
```

NAVCOMPARS MODEL: GPSS GENERATED STATISTICS

Figure D.1

APPENDIX E

TWENTY FOUR HOUR SIMULATION OF TEST DATA

```
1RELATIVE CLOCK       3600000  ABSOLUTE CLOCK       3600000
```

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	249	11	0	98	21	0	97	31	0	220	41	2	15
2	0	249	12	0	54	22	0	249	32	0	206	42	0	13
3	0	249	13	0	54	23	0	249	33	0	185	43	0	13
4	0	249	14	0	54	24	0	249	34	0	185	44	1	13
5	0	151	15	0	54	25	0	249	35	1	14	45	0	12
6	0	97	16	0	54	26	0	249	36	0	13	46	0	12
7	0	98	17	0	97	27	0	249	37	0	13	47	2	14
8	0	98	18	0	97	28	0	249	38	1	13	48	0	12
9	0	98	19	0	97	29	0	249	39	0	12	49	0	12
10	0	98	20	0	97	30	0	235	40	0	12	50	1	12

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	11	61	0	1									
52	0	11												
53	5	21												
54	0	16												
55	0	16												
56	1	16												
57	0	15												
58	0	15												
59	0	50												
60	0	1												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.049	98	1813.856		
ICHB	.025	54	1672.703		
ICHC	.144	97	5354.535		
PCUT	.368	249	5326.664		
CFTT	.686	13	189977.562	15	
CFEE	.616	13	170624.375	11	
CFCC	.547	12	164271.750	16	
CFAA	.772	16	173733.625	5	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	8	8	100.0	.000	.000		
2	1	.000	125	125	100.0	.000	.000		
3	1	.000	104	104	100.0	.000	.000		
4	1	.000	12	12	100.0	.000	.000		
6	2	.529	14	6	42.8	136185.812	238325.250		1
7	2	.330	15	8	53.3	79340.812	169973.250		2
8	3	.523	14	4	28.5	134501.812	188302.562		2
9	6	2.742	21	1	4.7	470113.375	493619.062		5
10	185	97.063	185		.0	1888807.000	1888807.000		185

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

```
*
*      DATA REQUIREMENTS
*
1      GENERATE    12034
       START       1
```

1RELATIVE CLOCK 720000 ABSOLUTE CLOCK 720000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	548	11	0	231	21	0	212	31	0	483	41	0	27
2	0	548	12	0	104	22	0	547	32	0	451	42	0	27
3	0	548	13	0	104	23	0	547	33	0	410	43	0	27
4	0	548	14	0	104	24	0	547	34	0	410	44	0	27
5	0	317	15	0	104	25	0	547	35	3	37	45	0	27
6	0	213	16	0	104	26	0	547	36	0	34	46	0	27
7	0	231	17	0	213	27	0	547	37	0	34	47	2	32
8	0	231	18	0	213	28	0	547	38	1	34	48	0	30
9	0	231	19	1	213	29	0	547	39	0	33	49	0	30
10	0	231	20	0	212	30	0	510	40	0	33	50	1	30

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	29	61	0	2									
52	0	29												
53	2	41												
54	0	39												
55	0	39												
56	1	39												
57	0	38												
58	0	38												
59	0	127												
60	0	2												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.056	231	1757.718		
ICHB	.024	104	1669.576		
ILHC	.156	213	5283.437	7	
PCUT	.398	547	5243.839		
CHTT	.843	34	178520.812	14	
CHEE	.681	27	181814.812		
CHCC	.715	30	172797.812	9	
CHAA	.885	39	163563.000	19	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	12	12	100.0	.000	.000		
2	1	.000	268	266	99.2	4.048	542.500		
3	1	.000	237	234	98.7	11.379	899.000		
4	1	.000	30	29	96.6	10.333	310.000		
6	6	1.954	37	6	16.2	380287.375	453891.375		3
7	2	.391	27	14	51.8	104399.250	216825.250		
8	4	.916	32	8	25.0	206284.125	275045.500		2
9	7	3.437	41	1	2.4	603614.875	618705.375		2
10	410	196.467	410		.0	3450161.000	3450163.000		410

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 16978

START 1

1RELATIVE CLOCK 10800000 ABSOLUTE CLOCK 10800000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	760	11	0	318	21	0	302	31	0	679	41	0	32
2	0	760	12	0	139	22	0	759	32	0	633	42	0	32
3	0	760	13	0	139	23	0	759	33	0	577	43	0	32
4	0	760	14	0	139	24	0	759	34	0	577	44	0	32
5	0	441	15	0	139	25	0	759	35	0	48	45	0	32
6	0	302	16	0	139	26	0	759	36	0	48	46	0	32
7	0	319	17	0	302	27	0	759	37	0	48	47	1	46
8	0	319	18	0	302	28	0	759	38	0	48	48	0	45
9	1	319	19	0	302	29	0	759	39	0	48	49	0	45
10	0	318	20	0	302	30	0	711	40	0	48	50	1	45

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	44	61	0	3									
52	0	44												
53	0	56												
54	0	56												
55	0	56												
56	1	56												
57	0	55												
58	0	55												
59	0	179												
60	0	3												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.052	319	1772.479	11	
ICHB	.021	139	1688.870		
ICHC	.148	302	5302.269		
PCUT	.371	759	5280.589		
CHTT	.802	48	180458.312		
CHEE	.523	32	176656.250		
CHCC	.737	45	176998.562	18	
CHAA	.867	56	171212.500	9	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	17	17	100.0	.000	.000		
2	1	.000	375	373	99.4	2.893	542.500		
3	1	.000	326	323	99.0	8.273	899.000		
4	1	.000	40	39	97.4	7.750	310.000		
5	1	.000	1	1	100.0	.000	.000		
6	6	1.460	48	11	22.9	328576.500	426261.437		
7	2	.260	32	19	59.3	88086.875	216825.250		
8	4	.758	46	14	30.4	178118.875	256045.937		1
9	7	2.587	56	4	7.1	498574.875	537357.562		
10	577	295.468	577		.0	5530810.000	5530810.000		577

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1	GENERATE	14347
	START	1

1RELATIVE CLOCK 1440000 ABSOLUTE CLOCK 1440000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1010	11	0	425	21	0	408	31	0	898	41	2	44
2	0	1010	12	0	177	22	0	1010	32	0	833	42	0	42
3	0	1010	13	0	177	23	0	1010	33	0	762	43	0	42
4	0	1010	14	0	177	24	0	1010	34	0	762	44	1	42
5	0	585	15	0	177	25	0	1010	35	2	68	45	0	41
6	0	408	16	0	177	26	0	1010	36	0	66	46	0	41
7	0	425	17	0	408	27	0	1010	37	0	66	47	1	65
8	0	425	18	0	408	28	0	1010	38	1	66	48	0	64
9	0	425	19	0	408	29	0	1010	39	0	65	49	0	64
10	0	425	20	0	408	30	0	942	40	0	65	50	1	64

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	63	61	0	4									
52	0	63												
53	1	71												
54	0	70												
55	0	70												
56	1	70												
57	0	69												
58	0	69												
59	0	238												
60	0	4												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.052	425	1766.248		
ICHB	.021	177	1721.000		
ICHC	.151	408	5347.519		
PCUT	.372	1010	5305.531		
CHTT	.813	66	177401.000	21	
CHEE	.518	42	177821.562	17	
CHCC	.775	64	174599.250	8	
CHAA	.855	70	176090.562	9	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	22	22	100.0	.000	.000		
2	1	.000	513	511	99.6	2.115	542.500		
3	1	.000	419	416	99.2	6.436	899.000		
4	1	.000	54	53	98.1	5.740	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	1.391	68	13	19.1	294618.000	364255.062		2
7	4	.333	44	24	54.5	109067.500	239946.562		2
8	4	.848	65	17	26.1	187864.750	254400.187		1
9	7	2.110	71	9	12.6	428111.437	490256.687		1
10	762	385.281	762		.0	7356508.000	7356509.000		762

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 20120
START 1

1RELATIVE CLOCK 1800000 ABSOLUTE CLOCK 18000000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1188	11	0	501	21	0	474	31	0	1054	41	0	51
2	0	1188	12	0	213	22	0	1188	32	0	976	42	0	51
3	0	1188	13	0	213	23	0	1188	33	0	890	43	0	51
4	0	1189	14	0	213	24	0	1188	34	0	890	44	1	51
5	0	687	15	0	213	25	0	1188	35	0	83	45	0	50
6	0	474	16	0	213	26	0	1188	36	0	83	46	0	50
7	0	501	17	0	474	27	0	1188	37	0	83	47	3	78
8	0	501	18	0	474	28	0	1188	38	1	83	48	0	75
9	0	501	19	0	474	29	0	1188	39	0	82	49	0	75
10	0	501	20	0	474	30	0	1105	40	0	82	50	1	75

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	74	61	0	5									
52	0	74												
53	0	86												
54	0	86												
55	0	86												
56	0	86												
57	0	86												
58	0	86												
59	0	292												
60	0	5												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.049	501	1766.353		
ICHE	.020	213	1727.600		
ICHC	.139	474	5303.695		
PCUT	.349	1188	5290.839		
CHTT	.809	83	175631.250	19	
CHEE	.508	51	179341.437	4	
CHCC	.738	75	177254.750	20	
CHAA	.834	86	174697.625		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	24	24	100.0	.000	.000		
2	1	.000	602	600	99.6	1.802	542.500		
3	1	.000	494	491	99.3	5.459	899.000		
4	1	.000	66	65	98.4	4.696	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	1.347	83	15	18.0	292189.187	356642.750		
7	4	.295	51	30	58.8	104350.000	253421.562		
8	4	.765	73	22	28.2	176760.312	246201.875		3
9	7	1.795	86	12	13.9	375665.187	436816.375		
10	890	476.317	890		.0	9633319.000	9633322.000		890

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 25707

START 1

1RELATIVE CLOCK 2160000 ABSOLUTE CLOCK 2160000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1328	11	0	555	21	0	531	31	0	1174	41	0	59
2	0	1328	12	0	241	22	0	1327	32	0	1084	42	0	59
3	0	1328	13	0	241	23	0	1327	33	0	989	43	0	59
4	0	1328	14	0	241	24	0	1327	34	0	989	44	0	59
5	0	772	15	0	241	25	0	1327	35	0	94	45	0	59
6	0	531	16	0	241	26	0	1327	36	0	94	46	0	59
7	0	556	17	0	531	27	0	1327	37	0	94	47	0	90
8	0	556	18	0	531	28	0	1327	38	0	94	48	0	90
9	1	556	19	0	531	29	0	1327	39	0	94	49	0	90
10	0	555	20	0	531	30	0	1233	40	0	94	50	1	90

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	69	61	0	6									
52	0	89												
53	0	95												
54	0	95												
55	0	95												
56	1	95												
57	0	94												
58	0	94												
59	0	336												
60	0	6												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.045	556	1766.674	6	
ICHB	.019	241	1730.315		
ICHC	.130	531	5314.285		
PCUT	.325	1327	5298.402		
CHTT	.779	94	179052.875		
CHEE	.491	59	179796.562		
CHCC	.730	90	175318.250	8	
CHAA	.755	95	171724.562	16	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	360000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	26	26	100.0	.000	.000		
2	1	.000	674	672	99.7	1.609	542.500		
3	1	.000	546	543	99.4	4.939	899.000		
4	1	.000	79	78	98.7	3.924	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	1.162	94	21	22.3	267046.500	343868.187		
7	4	.274	59	34	57.6	100610.687	237441.312		
8	4	.701	90	26	28.8	168361.562	236758.437		
9	7	1.513	95	17	17.8	344054.062	419040.250		
10	989	553.707	989		.0	2093103.000	2093106.000		989

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 23364

START 1

1RELATIVE CLOCK 2520000O ABSOLUTE CLOCK 25200000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1482	11	0	619	21	0	592	31	0	1317	41	0	64
2	0	1482	12	0	271	22	0	1482	32	0	1216	42	0	64
3	0	1482	13	0	271	23	0	1482	33	0	1113	43	0	64
4	0	1482	14	0	271	24	0	1482	34	0	1113	44	0	64
5	0	863	15	0	271	25	0	1482	35	0	100	45	0	64
6	0	592	16	0	271	26	1	1482	36	0	100	46	0	64
7	0	619	17	0	592	27	0	1481	37	0	100	47	0	101
8	0	619	18	0	592	28	0	1481	38	0	100	48	0	101
9	0	619	19	0	592	29	0	1481	39	0	100	49	0	101
10	0	619	20	0	592	30	0	1381	40	0	100	50	1	101

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	100	61	0	7									
52	0	100												
53	0	103												
54	0	103												
55	0	103												
56	0	103												
57	0	103												
58	0	103												
59	0	367												
60	0	7												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.043	619	1764.579		
ICHB	.018	271	1739.800		
ICHC	.125	592	5338.824		
PCUT	.312	1482	5305.988	16	
CHTT	.702	100	177077.750		
CHEE	.453	64	178468.750		
CHCC	.692	101	172777.187	21	
CHAA	.711	103	174017.812		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	36C000C								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	28	28	100.0	.000	.000		
2	1	.000	753	751	99.7	1.440	542.500		
3	1	.000	611	608	99.5	4.414	899.000		
4	1	.000	88	87	98.8	3.522	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.997	100	26	25.9	251417.125	339752.937		
7	4	.255	64	39	60.9	52750.500	237441.312		
8	4	.617	101	33	32.6	154009.000	228748.687		
9	7	1.304	103	22	21.3	319234.500	405940.250		
10	1113	624.668	1113		.0	4143363.000	4143363.000		1113

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 28329
START 1

1RELATIVE CLOCK 28800000 ABSOLUTE CLOCK 28800000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1609	11	0	680	21	0	638	31	0	1427	41	0	72
2	0	1609	12	0	291	22	0	1609	32	0	1320	42	0	72
3	0	1609	13	0	291	23	0	1609	33	0	1208	43	0	72
4	0	1609	14	0	291	24	0	1609	34	0	1208	44	0	72
5	0	929	15	0	291	25	0	1609	35	0	109	45	0	72
6	0	638	16	0	291	26	1	1609	36	0	109	46	0	72
7	0	680	17	0	638	27	0	1608	37	0	109	47	0	107
8	0	680	18	0	638	28	0	1608	38	0	109	48	0	107
9	0	680	19	0	638	29	0	1608	39	0	109	49	0	107
10	0	680	20	0	638	30	0	1499	40	0	109	50	0	107

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	107	61	0	8									
52	0	107												
53	0	112												
54	0	112												
55	0	112												
56	0	112												
57	0	112												
58	0	112												
59	0	400												
60	0	8												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.041	680	1759.285		
ICHB	.017	291	1733.000		
ICHC	.117	638	5320.281		
PCUT	.295	1609	5283.578	8	
CHTT	.665	109	175869.625		
CHEE	.439	72	175611.062		
CHCC	.645	107	173625.375		
CHAA	.673	112	173688.000		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	29	29	100.0	.000	.000		
2	1	.000	817	815	99.7	1.328	542.500		
3	1	.000	670	667	99.5	4.025	895.000		
4	1	.000	91	90	98.9	3.406	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.905	109	31	28.4	239369.312	334503.312		
7	4	.218	72	44	61.1	87226.000	224295.500		
8	4	.543	107	38	35.5	146379.312	226994.000		
9	7	1.161	112	27	24.1	298650.125	393515.500		
10	1208	691.560	1208		.0	6487539.000	6487541.000		1208

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

```
1      GENERATE    26455
       START       1
```

1RELATIVE CLOCK 3240000 ABSOLUTE CLOCK 3240000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1745	11	0	738	21	0	699	31	0	1550	41	0	77
2	0	1745	12	0	308	22	0	1745	32	0	1435	42	0	77
3	0	1745	13	0	308	23	0	1745	33	0	1314	43	0	77
4	0	1745	14	0	308	24	0	1745	34	0	1314	44	1	77
5	0	1007	15	0	308	25	0	1745	35	0	117	45	0	76
6	0	699	16	0	308	26	1	1745	36	0	117	46	0	76
7	0	738	17	0	699	27	0	1744	37	0	117	47	0	115
8	0	738	18	0	699	28	0	1744	38	0	117	48	0	115
9	0	738	19	0	699	29	0	1744	39	0	117	49	0	115
10	0	738	20	0	699	30	0	1627	40	0	117	50	0	115

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	115	61	0	9									
52	0	115												
53	0	121												
54	0	121												
55	0	121												
56	0	121												
57	0	121												
58	0	121												
59	0	425												
60	0	9												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.040	738	1759.184		
ICHB	.016	308	1727.733		
ICHC	.114	699	5308.003		
PCUT	.284	1745	5281.925	8	
CHTT	.632	117	175254.937		
CHEE	.413	77	174026.250	18	
CHCC	.615	115	173521.250		
CHAA	.651	121	174536.937		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	30	30	100.0	.000	.000		
2	1	.000	867	835	99.7	1.223	542.500		
3	1	.000	725	722	99.5	3.719	855.000		
4	1	.000	101	100	99.0	3.069	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.808	117	38	32.4	223903.500	331604.000		
7	4	.193	77	49	63.6	81562.000	224255.500		
8	4	.509	115	42	36.5	143599.062	226217.687		
9	7	1.083	121	30	24.7	250073.250	385701.812		
10	1314	754.755	1314		.0	8610336.000	8610336.000		1314

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 34014
START 1

1RELATIVE CLOCK 3600000 ABSOLUTE CLOCK 3600000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1850	11	0	790	21	0	731	31	0	1645	41	0	84
2	0	1850	12	0	329	22	0	1850	32	0	1523	42	0	84
3	0	1850	13	0	329	23	0	1850	33	0	1393	43	0	84
4	0	1850	14	0	329	24	0	1850	34	0	1393	44	0	84
5	0	1060	15	0	329	25	0	1850	35	0	121	45	0	84
6	0	731	16	0	329	26	0	1850	36	0	121	46	0	84
7	0	790	17	0	731	27	0	1850	37	0	121	47	0	122
8	0	790	18	0	731	28	0	1850	38	0	121	48	0	122
9	0	790	19	0	731	29	0	1850	39	0	121	49	0	122
10	0	790	20	0	731	30	0	1729	40	0	121	50	0	122

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	122	61	0	10									
52	0	122												
53	0	130												
54	0	130												
55	0	130												
56	0	130												
57	0	130												
58	0	130												
59	0	457												
60	0	10												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.038	790	1761.733		
ICHB	.015	329	1734.209		
ICHC	.107	731	5297.992		
PCUT	.271	1850	5286.406		
CHTT	.587	121	174693.500		
CHEE	.408	84	174940.437		
CHCC	.585	122	172711.812		
CHAA	.632	130	175021.250		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	33	33	100.0	.000	.000		
2	1	.000	943	941	99.7	1.150	542.500		
3	1	.000	764	761	99.6	3.530	899.000		
4	1	.000	109	107	99.0	2.870	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.729	121	41	33.8	217088.000	328345.625		
7	4	.180	34	54	64.2	77492.937	216980.250		
8	4	.460	122	48	39.3	136014.937	224240.812		
9	7	.984	130	36	27.6	272709.062	377150.812		
10	1393	814.455	1393		.0	1048336.000	1048336.000		1393

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 41494
START 1

1RELATIVE CLOCK 39600000 ABSOLUTE CLOCK 39600000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1936	11	0	822	21	0	771	31	0	1721	41	0	88
2	0	1936	12	0	343	22	0	1936	32	0	1587	42	0	88
3	0	1936	13	0	343	23	0	1936	33	0	1452	43	0	88
4	0	1936	14	0	343	24	0	1936	34	0	1452	44	0	88
5	0	1114	15	0	343	25	0	1936	35	0	127	45	0	88
6	0	771	16	0	343	26	0	1936	36	0	127	46	0	88
7	0	822	17	0	771	27	0	1936	37	0	127	47	0	134
8	0	822	18	0	771	28	0	1936	38	0	127	48	0	134
9	0	322	19	0	771	29	0	1936	39	0	127	49	0	134
10	0	322	20	0	771	30	0	1809	40	0	127	50	1	134

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	133	61	0	11									
52	0	133												
53	0	135												
54	0	135												
55	0	135												
56	0	135												
57	0	135												
58	0	135												
59	0	463												
60	0	11												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.036	822	1757.649		
ICHB	.014	343	1731.314		
ICHC	.103	771	5301.464		
PCUT	.258	1936	5281.066		
CHTT	.560	127	174614.125		
CHEE	.386	88	174147.687		
CHCC	.585	134	173080.812		
CHAA	.596	135	175117.250		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	35	35	100.0	.000	.000		
2	1	.000	986	984	99.7	1.100	542.500		
3	1	.000	801	798	99.6	3.367	899.000		
4	1	.000	112	111	99.1	2.767	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.665	127	46	36.2	207393.000	325171.812		
7	4	.164	88	58	65.9	73970.500	216980.250		
8	4	.437	134	54	40.2	129392.687	216732.812		
9	7	.695	135	41	30.3	262608.687	377150.812		
10	1452	805.797	1452		.0	3721680.000	3721680.000		1452

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

```
1       GENERATE    38314
        START       1
```

1RELATIVE CLOCK 43200000 ABSOLUTE CLOCK 43200000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	2029	11	0	857	21	0	817	31	0	1806	41	0	93
2	0	2029	12	0	355	22	0	2029	32	0	1664	42	0	93
3	0	2029	13	0	355	23	0	2029	33	0	1524	43	0	93
4	0	2029	14	0	355	24	0	2029	34	0	1524	44	0	93
5	0	1172	15	0	355	25	0	2029	35	0	130	45	0	93
6	0	817	16	0	355	26	0	2029	36	0	130	46	0	93
7	0	857	17	0	817	27	0	2029	37	0	130	47	0	142
8	0	857	18	0	817	28	0	2029	38	1	130	48	0	142
9	0	857	19	0	817	29	0	2029	39	0	129	49	0	142
10	0	857	20	0	817	30	0	1899	40	0	129	50	0	142

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	142	61	0	12									
52	0	142												
53	1	140												
54	0	139												
55	0	139												
56	1	139												
57	0	138												
58	0	138												
59	0	502												
60	0	12												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
1CHA	.034	857	1760.044		
1CHB	.014	355	1725.199		
1CHC	.100	817	5301.710		
PCUT	.248	2029	5281.289		
CHTT	.525	130	174676.625	21	
CFEE	.372	93	172892.437		
CFCC	.570	142	173429.125		
CHAA	.560	139	174249.437	20	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE
1	360000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	37	37	100.0	.000	.000		
2	1	.000	1033	1031	99.8	1.050	542.500		
3	1	.000	839	836	99.6	3.214	895.000		
4	1	.000	118	117	99.1	2.627	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.609	130	49	37.6	202607.000	325171.812		
7	4	.152	93	62	66.6	70646.000	211938.000		
8	4	.409	142	60	42.2	124685.750	215919.187		
9	7	.821	140	44	31.4	253484.687	369665.187		1
10	1524	921.368	1524		.0	6117552.000	6117552.000		1524

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 29762

START 1

```
1RELATIVE CLOCK      46800000  ABSOLUTE CLOCK      46800000
 BLOCK COUNTS
 BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL
     1       0      2149      11       0       900      21       0       868      31       0      1914      41       0        94
     2       0      2149      12       0       381      22       0      2149      32       0      1761      42       0        94
     3       0      2149      13       0       381      23       0      2149      33       0      1610      43       0        94
     4       0      2149      14       0       381      24       0      2149      34       0      1610      44       0        94
     5       0      1249      15       0       381      25       0      2149      35       0       141      45       0        94
     6       0       868      16       0       381      26       0      2149      36       0       141      46       0        94
     7       0       900      17       0       868      27       0      2149      37       0       141      47       0       153
     8       0       900      18       0       868      28       0      2149      38       0       141      48       0       153
     9       0       900      19       0       868      29       0      2149      39       0       141      49       0       153
    10       0       900      20       0       868      30       0      2008      40       0       141      50       1       153
 BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL   BLOCK CURRENT     TOTAL
    51       0       152      61       0        13
    52       0       152
    53       0       151
    54       0       151
    55       0       151
    56       0       151
    57       0       151
    58       0       151
    59       0       538
    60       0        12

 FACILITY         AVERAGE         NUMBER        AVERAGE         SEIZING    PREEMPTING
               UTILIZATION       ENTRIES      TIME/TRAN       TRANS. NO.   TRANS. NO.
    ICHA           .033             900        1759.755
    ICHB           .014             381        1725.805
    ICHC           .098             868        5293.472
    PCUT           .242            2149        5277.699
    CFTT           .522             141      173361.000
    CHEE           .346              94      173574.437
    CFCC           .563             153      172375.000           6
    CFAA           .563             151      174647.937

 CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)
 SAVEVALUE  NR,       VALUE        NR,       VALUE        NR,        VALUE        NR,        VALUE        NR,        VALUE
              1      3600000

 QUEUE        MAXIMUM     AVERAGE     TOTAL      ZERO     PERCENT       AVERAGE       $AVERAGE      TABLE      CURRENT
             CONTENTS    CONTENTS    ENTRIES    ENTRIES     ZEROS     TIME/TRANS     TIME/TRANS     NUMBER    CONTENTS
     1             1        .000        37         37      100.0          .000           .000
     2             1        .000      1093       1091       99.8          .992        542.500
     3             1        .000       890        887       99.6         3.030        899.000
     4             1        .000       127        126       99.2         2.440        310.000
     5             1        .000         2          2      100.0          .000           .000
     6             6        .567       141         56       39.7    188330.187     312406.625
     7             4        .140        94         63       67.0     69894.437     211938.000
     8             4        .382       153         69       45.0    116979.500     213069.812
     9             7        .731       151         50       33.1    242172.937     362060.562
    10          1610     970.967      1610                    .0   8224304.000    8224304.000                   1610
 $AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES
 1      GENERATE    22779
        START       1
```

1RELATIVE CLOCK 5040000 ABSOLUTE CLOCK 5040000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	2307	11	0	963	21	0	927	31	0	2054	41	0	99
2	0	2307	12	0	417	22	0	2306	32	0	1891	42	0	99
3	0	2307	13	0	417	23	0	2306	33	0	1730	43	0	99
4	0	2307	14	1	417	24	0	2306	34	0	1730	44	0	99
5	0	1344	15	0	416	25	0	2306	35	0	153	45	0	99
6	0	927	16	0	416	26	0	2306	36	0	153	46	0	99
7	0	963	17	0	927	27	0	2306	37	0	153	47	2	163
8	0	963	18	0	927	28	0	2306	38	0	153	48	0	161
9	0	963	19	0	927	29	0	2306	39	0	153	49	0	161
10	0	963	20	0	927	30	0	2153	40	0	153	50	1	161

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	160	61	0	14									
52	0	160												
53	0	161												
54	0	161												
55	0	161												
56	0	161												
57	0	161												
58	0	161												
59	0	573												
60	0	14												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.033	963	1756.507		
ICHB	.014	417	1726.167	6	
ICHC	.097	927	5306.414		
PCUT	.241	2306	5279.742		
CHTT	.531	153	175104.000		
CHEE	.344	99	175522.875		
CHCC	.553	161	173331.062	18	
CHAA	.557	161	174639.687		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	38	38	100.0	.000	.000		
2	1	.000	1170	1168	99.8	.927	542.500		
3	1	.000	957	954	99.6	2.818	895.000		
4	1	.000	139	138	99.2	2.230	310.000		
5	1	.000	2	2	100.0	.000	.000		
6	6	.536	153	62	40.5	176633.750	296977.625		
7	4	.130	99	68	63.6	66364.375	211938.000		
8	4	.369	163	73	44.7	114332.625	207065.187		2
9	7	.742	161	53	32.9	232400.437	346448.875		
10	1730	1020.424	1730		.0	9742544.000	9742544.000		1730

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 23095

START 1

1RELATIVE CLOCK 5400000 ABSOLUTE CLOCK 5400000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	2462	11	0	1027	21	0	987	31	0	2195	41	0	106
2	0	2462	12	0	448	22	0	2462	32	0	2018	42	0	106
3	0	2462	13	0	448	23	0	2462	33	0	1850	43	0	106
4	0	2462	14	0	448	24	0	2462	34	0	1850	44	1	106
5	0	1435	15	0	448	25	0	2462	35	0	161	45	0	105
6	0	987	16	0	448	26	0	2462	36	0	161	46	0	105
7	0	1027	17	0	987	27	0	2462	37	0	161	47	0	177
8	0	1027	18	0	987	28	0	2462	38	0	161	48	0	177
9	0	1027	19	0	957	29	0	2462	39	0	161	49	0	177
10	0	1027	20	0	987	30	0	2301	40	0	161	50	0	177

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	177	61	0	15									
52	0	177												
53	0	168												
54	0	168												
55	0	168												
56	0	168												
57	0	168												
58	0	168												
59	0	611												
60	0	15												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.033	1027	1755.597		
ICHB	.014	448	1724.091		
ICHC	.096	987	5291.992		
PCUT	.246	2462	5270.429		
CHTT	.519	161	174360.187		
CHEF	.345	106	176253.562	6	
CHCL	.554	177	172101.375		
CHAA	.539	168	173440.000		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3000000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	42	42	100.0	.000	.000		
2	1	.000	1248	1246	99.8	.869	542.500		
3	1	.000	1023	1020	99.7	2.636	899.000		
4	1	.000	145	144	99.3	2.137	310.000		
5	1	.000	4	4	100.0	.000	.000		
6	6	.506	161	68	42.2	169752.625	293872.875		
7	4	.129	106	72	67.9	65978.187	205696.750		
8	4	.377	177	79	44.6	115173.062	208010.625		
9	7	.592	168	60	35.7	222717.062	346448.875		
10	1850	1072.132	1850		.0	1296048.000	1296048.000		1850

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 16287
START 1

1RELATIVE CLOCK 5760000 ABSOLUTE CLOCK 5760000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	2683	11	0	1113	21	0	1075	31	0	2390	41	0	116
2	0	2683	12	0	494	22	0	2682	32	0	2197	42	0	116
3	0	2683	13	0	494	23	0	2682	33	0	2015	43	0	116
4	0	2683	14	0	494	24	0	2682	34	0	2015	44	0	116
5	0	1570	15	0	494	25	0	2682	35	0	176	45	0	116
6	0	1076	16	0	494	26	0	2682	36	0	176	46	0	116
7	0	1113	17	0	1075	27	0	2682	37	0	176	47	0	193
8	0	1113	18	0	1076	28	0	2682	38	0	176	48	0	193
9	0	1113	19	1	1076	29	0	2682	39	0	176	49	0	193
10	0	1113	20	0	1075	30	0	2506	40	0	176	50	1	193

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	192	61	0	16									
52	0	192												
53	0	182												
54	0	182												
55	0	182												
56	1	182												
57	0	181												
58	0	181												
59	0	665												
60	0	16												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.033	1113	1755.299		
ICHB	.014	494	1727.076		
ICHC	.098	1076	5267.210	6	
PCUT	.245	2682	5263.300		
CHTT	.530	176	173534.875		
CHEL	.353	116	175360.000		
CHCC	.576	193	171993.500	8	
CHAA	.551	182	174480.312	7	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	42	42	100.0	.000	.000		
2	1	.000	1352	1350	99.8	.802	542.500		
3	1	.000	1127	1124	99.7	2.393	899.000		
4	1	.000	155	154	99.3	2.000	310.000		
5	1	.000	6	6	100.0	.000	.000		
6	6	.525	176	75	42.6	172225.250	300115.312		
7	4	.127	116	78	67.2	63292.453	193208.500		
8	4	.381	193	85	44.0	113708.125	203200.625		
9	7	.636	132	65	35.7	217993.875	339105.375		
10	2015	1125.825	2015		.0	2182400.000	2182400.000		2015

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 17637
START 1

1RELATIVE CLOCK 61200000 ABSOLUTE CLOCK 61200000
BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	2887	11	0	1200	21	0	1159	31	0	2579	41	0	124
2	0	2887	12	0	528	22	0	2887	32	0	2371	42	0	124
3	0	2887	13	0	528	23	0	2887	33	0	2169	43	0	124
4	0	2887	14	0	528	24	0	2887	34	0	2169	44	0	124
5	0	1687	15	0	528	25	0	2887	35	0	183	45	0	124
6	0	1159	16	0	528	26	1	2887	36	0	183	46	0	124
7	0	1200	17	0	1159	27	0	2886	37	0	183	47	0	208
8	0	1200	18	0	1159	28	0	2886	38	0	183	48	0	208
9	0	1200	19	0	1159	29	0	2886	39	0	183	49	0	208
10	0	1200	20	0	1159	30	0	2703	40	0	183	50	0	208

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	208	61	0	17									
52	0	208												
53	0	202												
54	0	202												
55	0	202												
56	0	202												
57	0	202												
58	0	202												
59	0	717												
60	0	17												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.034	1200	1749.577		
ICHF	.014	526	1733.604		
ICHC	.099	1159	5270.007		
PCUT	.248	2887	5260.351	14	
CHTT	.516	183	172737.000		
CHEF	.356	124	175517.375		
CHCC	.588	208	173032.562		
CHAA	.571	202	173182.687		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	44	44	100.0	.000	.000		
2	1	.000	1453	1451	99.8	.746	542.500		
3	1	.000	1213	1210	99.7	2.223	399.000		
4	1	.000	171	170	99.4	1.812	310.000		
5	1	.000	6	6	100.0	.000	.000		
6	6	.437	133	80	43.7	160233.312	295346.625		
7	4	.121	124	85	68.5	60141.144	191218.000		
8	4	.399	208	91	43.7	117428.000	208760.875		
9	7	.746	202	66	32.6	226163.562	335919.500		
10	2169	1182.438	2169		.0	3363328.000	3363344.000		2169

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES
1 GENERATE 14065
START 1

1RELATIVE CLOCK 6480000 ABSOLUTE CLOCK 64800000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	3142	11	0	1318	21	0	1259	31	0	2816	41	0	130
2	0	3142	12	0	565	22	0	3142	32	0	2583	42	0	130
3	0	3142	13	0	565	23	0	3142	33	0	2364	43	0	130
4	0	3142	14	0	565	24	0	3142	34	0	2364	44	0	130
5	0	1824	15	0	565	25	0	3142	35	0	196	45	0	130
6	0	1259	16	0	565	26	0	3142	36	0	196	46	0	130
7	0	1318	17	0	1259	27	0	3142	37	0	196	47	8	233
8	0	1318	18	0	1259	28	0	3142	38	1	196	48	0	225
9	0	1318	19	0	1259	29	0	3142	39	0	195	49	0	225
10	0	1318	20	0	1259	30	0	2946	40	0	195	50	1	225

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	224	61	0	18									
52	0	224												
53	2	219												
54	0	217												
55	0	217												
56	1	217												
57	0	216												
58	0	216												
59	0	765												
60	0	18												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.035	1318	1752.278		
ICHB	.015	565	1734.676		
ICHL	.102	1259	5278.363		
PCUT	.255	3142	5266.695		
CHTT	.519	196	171889.625	10	
CHLE	.351	130	175245.750		
CHCC	.602	225	173566.812	17	
CHAA	.580	217	173346.187	18	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	47	47	100.0	.000	.000		
2	1	.000	1580	1578	99.8	.686	542.500		
3	1	.000	1325	1322	99.7	2.035	899.000		
4	1	.000	183	182	99.4	1.693	310.000		
5	1	.000	7	7	100.0	.000	.000		
6	6	.433	196	87	44.3	159724.750	287211.562		
7	4	.125	130	88	67.6	62552.414	193614.562		
8	8	.511	233	95	40.7	142280.562	240227.312		8
9	7	.734	219	71	32.4	217459.250	321780.937		2
10	2364	1242.707	2364		.0	4064064.000	4064064.000		2364

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 12547
START 1

1RELATIVE CLOCK 6840000 ABSOLUTE CLOCK 6840000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	3428	11	0	1434	21	0	1380	31	0	3062	41	1	151
2	0	3428	12	0	614	22	0	3428	32	0	2808	42	0	150
3	0	3428	13	0	614	23	0	3428	33	0	2565	43	0	150
4	0	3428	14	0	614	24	0	3428	34	0	2565	44	1	150
5	0	1994	15	0	614	25	0	3428	35	0	215	45	0	149
6	0	1380	16	0	614	26	0	3428	36	0	215	46	0	149
7	0	1434	17	0	1380	27	0	3428	37	0	215	47	8	254
8	0	1434	18	0	1380	28	0	3428	38	1	215	48	0	246
9	0	1434	19	0	1380	29	0	3428	39	0	214	49	0	246
10	0	1434	20	0	1380	30	0	3213	40	0	214	50	1	246

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	245	61	0	19									
52	0	245												
53	7	243												
54	0	236												
55	0	236												
56	1	236												
57	0	235												
58	0	235												
59	0	843												
60	0	19												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.036	1434	1751.140		
ICHB	.015	614	1735.607		
ICHC	.106	1380	5277.566		
PCUT	.263	3428	5265.472		
CFTT	.544	215	173364.375	11	
CFEL	.383	150	175085.167	26	
CFCC	.623	246	173363.750	32	
CFAA	.602	236	174645.125	13	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	360000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	51	51	100.0	.000	.000		
2	1	.000	1716	1713	99.8	.921	527.333		
3	1	.000	1454	1448	99.5	2.916	706.633		
4	1	.000	200	198	98.9	2.375	237.500		
5	1	.000	7	7	100.0	.000	.000		
6	6	.533	215	88	40.9	169728.500	287335.687		
7	4	.176	151	91	60.2	79952.875	201214.812		1
8	11	.936	254	95	37.4	252651.187	403606.312		8
9	11	1.007	243	71	29.2	306121.625	432485.812		7
10	2565	1306.721	2565		.0	4845824.000	4845824.000		2565

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 14184

START 1

1RELATIVE CLOCK 7200000 ABSOLUTE CLOCK 7200000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	3681	11	0	1550	21	0	1477	31	0	3281	41	0	166
2	0	3681	12	0	654	22	0	3681	32	0	3006	42	0	166
3	0	3681	13	0	654	23	0	3681	33	0	2748	43	0	166
4	0	3681	14	0	654	24	0	3681	34	0	2748	44	0	166
5	0	2131	15	0	654	25	0	3681	35	0	234	45	0	166
6	0	1477	16	0	654	26	0	3681	36	0	234	46	0	166
7	0	1550	17	0	1477	27	0	3681	37	0	234	47	8	275
8	0	1550	18	0	1477	28	0	3681	38	1	234	48	0	267
9	0	1550	19	0	1477	29	0	3681	39	0	233	49	0	267
10	0	1550	20	0	1477	30	0	3447	40	0	233	50	1	267

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	266	61	0	20									
52	0	266												
53	3	258												
54	0	255												
55	0	255												
56	1	255												
57	0	254												
58	0	254												
59	0	919												
60	0	20												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.037	1550	1750.197		
ICHB	.015	654	1738.775		
ICHC	.108	1477	5269.496		
PCUT	.269	3681	5262.777		
CHTT	.563	234	173304.312	2	
CHEE	.401	166	174336.000		
CHCC	.642	267	173230.500	15	
CHAA	.622	255	175749.500	13	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	52	52	100.0	.000	.000		
2	1	.000	1846	1843	99.8	.856	527.333		
3	1	.000	1560	1554	99.6	2.718	706.833		
4	1	.000	216	214	99.0	2.199	237.500		
5	1	.000	7	7	100.0	.000	.000		
6	6	.541	234	92	39.3	166560.437	274472.875		
7	4	.179	166	99	59.6	77803.187	192766.125		
8	12	1.347	275	95	34.5	352857.250	539087.562		8
9	11	1.278	253	71	27.5	356886.187	492388.500		3
10	2748	1374.036	2748		.0	6000944.000	6000944.000		2748

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 14409
START 1

1RELATIVE CLOCK 7560000 ABSOLUTE CLOCK 7560000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	3930	11	0	1647	21	0	1589	31	0	3506	41	0	177
2	0	3930	12	0	694	22	0	3930	32	0	3207	42	0	177
3	0	3930	13	0	694	23	0	3930	33	0	2934	43	0	177
4	0	3930	14	0	694	24	0	3930	34	0	2934	44	0	177
5	0	2283	15	0	694	25	0	3930	35	0	247	45	0	177
6	0	1589	16	0	694	26	0	3930	36	0	247	46	0	177
7	0	1647	17	0	1589	27	0	3930	37	0	247	47	11	299
8	0	1647	18	0	1589	28	0	3930	38	1	247	48	0	288
9	0	1647	19	0	1589	29	0	3930	39	0	246	49	0	288
10	0	1647	20	0	1589	30	0	3083	40	0	246	50	1	288

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	287	61	0	21									
52	0	287												
53	0	273												
54	0	273												
55	0	273												
56	0	273												
57	0	273												
58	0	273												
59	0	983												
60	0	21												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.038	1647	1752.031		
ICHB	.015	694	1741.331		
ICHC	.110	1589	5263.976		
PCUT	.273	3930	5264.281		
CHTT	.565	247	173050.812	16	
CHEE	.405	177	173166.125		
CHCC	.655	288	173098.625	24	
CHAA	.635	273	176054.812		

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	53	53	100.0	.000	.000		
2	1	.000	1965	1962	99.8	.805	527.333		
3	1	.000	1666	1660	99.6	2.545	706.833		
4	1	.000	239	237	99.1	1.987	237.500		
5	1	.000	7	7	100.0	.000	.000		
6	6	.526	247	99	40.0	161110.375	268880.250		
7	4	.174	177	106	59.8	74463.687	185634.937		
8	12	1.671	299	95	31.7	422591.687	619386.875		11
9	11	1.339	273	71	26.0	370872.625	501225.000		
10	2934	1443.868	2934		.0	7203904.000	7203904.000		2934

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 12034

START 1

1RELATIVE CLOCK 79200000 ABSOLUTE CLOCK 79200000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	4229	11	0	1788	21	0	1694	31	0	3760	41	5	197
2	0	4229	12	0	746	22	0	4228	32	0	3443	42	0	192
3	0	4229	13	0	746	23	0	4228	33	0	3153	43	0	192
4	0	4229	14	0	746	24	0	4228	34	0	3153	44	1	192
5	0	2441	15	0	746	25	0	4228	35	5	271	45	0	191
6	0	1695	16	0	746	26	0	4228	36	0	266	46	0	191
7	0	1788	17	0	1695	27	0	4228	37	0	266	47	10	317
8	0	1788	18	0	1695	28	0	4228	38	1	266	48	0	307
9	0	1788	19	1	1695	29	0	4228	39	0	265	49	0	307
10	0	1788	20	0	1694	30	0	3957	40	0	265	50	1	307

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	306	61	0	22									
52	0	306												
53	0	290												
54	0	290												
55	0	290												
56	1	290												
57	0	289												
58	0	289												
59	0	1051												
60	0	22												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.339	1788	1747.351		
ICHB	.016	746	1746.288		
ICHC	.112	1695	5264.464	6	
PCUT	.280	4228	5261.984		
CHTT	.582	266	173540.062	4	
CHEE	.427	192	174384.000	14	
CHCC	.674	307	174112.500	33	
CHAA	.644	290	175918.750	32	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	56	56	100.0	.000	.000		
2	1	.000	2104	2100	99.8	.930	485.250		
3	1	.000	1803	1789	99.2	5.155	663.928		
4	1	.000	253	255	98.8	6.434	553.333		
5	1	.000	7	7	100.0	.000	.000		
6	7	.653	271	100	36.9	192360.687	304852.437		5
7	5	.209	197	112	56.8	84030.250	194752.437		5
8	14	2.163	317	95	29.9	540582.250	771912.750		10
9	11	1.308	290	76	26.2	357354.187	484265.312		
10	3153	1516.554	3153		.0	8093728.000	8093728.000		3153

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 12604
START 1

1RELATIVE CLOCK 82800000 ABSOLUTE CLOCK 82800000

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	4510	11	0	1910	21	0	1806	31	0	4009	41	0	212
2	0	4510	12	0	794	22	0	4510	32	0	3667	42	0	212
3	0	4510	13	0	794	23	0	4510	33	0	3349	43	0	212
4	0	4510	14	0	794	24	0	4510	34	0	3349	44	0	212
5	0	2600	15	0	794	25	0	4510	35	2	288	45	0	212
6	0	1806	16	0	794	26	1	4510	36	0	286	46	0	212
7	0	1910	17	0	1806	27	0	4509	37	0	286	47	14	342
8	0	1910	18	0	1806	28	0	4509	38	1	286	48	0	328
9	0	1910	19	0	1806	29	0	4509	39	0	285	49	0	328
10	0	1910	20	0	1806	30	0	4221	40	0	285	50	1	328

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	327	61	0	23									
52	0	327												
53	10	318												
54	0	308												
55	0	308												
56	1	308												
57	0	307												
58	0	307												
59	0	1131												
60	0	23												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.040	1910	1750.150		
ICHB	.016	794	1748.396		
ICHC	.114	1806	5270.300		
PCUT	.286	4510	5266.843	14	
CFTT	.600	286	173992.250	26	
CHEE	.447	212	174848.000		
CHCC	.689	328	173940.250	30	
CHAA	.654	308	176011.625	27	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE	NR.	VALUE
1	360000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	59	59	100.0	.000	.000		
2	1	.000	2227	2221	99.7	1.561	579.666		
3	1	.000	1945	1931	99.2	4.778	663.928		
4	1	.000	271	268	98.8	6.125	553.333		
5	1	.000	8	8	100.0	.000	.000		
6	8	.857	288	100	34.7	240678.937	368695.937		2
7	5	.275	212	112	52.8	107482.312	227862.500		
8	14	2.513	342	95	27.7	608559.312	842620.675		14
9	11	1.510	318	78	24.5	393210.562	521004.187		10
10	3349	1591.943	3349		.0	9358832.000	9358832.000		3349

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

1 GENERATE 12642

START 1

RELATIVE CLOCK 864000CO ABSOLUTE CLOCK 8640000O

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	4794	11	0	2023	21	0	1925	31	0	4260	41	2	230
2	0	4794	12	0	846	22	0	4794	32	0	3898	42	0	228
3	0	4794	13	0	846	23	0	4794	33	0	3557	43	0	228
4	0	4794	14	0	846	24	0	4794	34	0	3557	44	1	228
5	0	2771	15	0	846	25	0	4794	35	3	304	45	0	227
6	0	1925	16	0	846	26	0	4794	36	0	301	46	0	227
7	0	2023	17	0	1925	27	0	4794	37	0	301	47	13	362
8	0	2023	18	0	1925	28	0	4794	38	1	301	48	0	349
9	0	2023	19	0	1925	29	0	4794	39	0	300	49	0	349
10	0	2023	20	0	1925	30	0	4490	40	0	300	50	1	349

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	348	61	0	24									
52	0	348												
53	13	341												
54	0	328												
55	0	328												
56	1	325												
57	0	327												
58	0	327												
59	0	1202												
60	0	24												

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
ICHA	.041	2023	1751.909		
ICHB	.017	846	1752.796		
ICHC	.117	1925	5274.539		
PCUT	.292	4794	5274.484		
CHTT	.605	301	173794.187	33	
CHEE	.462	228	175155.625	29	
CHCC	.701	349	173769.500	23	
CHAA	.669	328	176255.187	5	

CONTENTS OF FULLWORD SAVEVALUES (NON-ZERO)

SAVEVALUE NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE	NR,	VALUE
1	3600000								

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
1	1	.000	62	62	100.0	.000	.000		
2	1	.000	2372	2364	99.6	1.706	506.125		
3	1	.000	2060	2050	99.2	5.169	667.562		
4	1	.000	285	282	98.9	5.824	553.333		
5	1	.000	9	9	100.0	.000	.000		
6	8	.345	304	104	34.2	240322.250	365290.125		3
7	5	.330	230	115	50.0	124073.187	248146.375		2
8	16	2.962	362	95	26.2	707038.937	958607.187		13
9	15	1.935	341	78	22.8	490356.562	635785.812		13
10	3557	1067.463	3557		.0	551472.000	551488.000		3557

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

END

BIBLIOGRAPHY

Bohl, M., Information Processing, Science Research Associates, Incorporated, 1971

International Business Machines Corporation Manual Number GH20-0304-4, General Purpose Simulation System/360 Introductory User's Manual, 5th ed., November 1969.

International Business Machines Corporation Manual Number GH20-0326, General Purpose Simulation System/360 User's Manual.

Martin, E. W. and Perkins, W.C., Computers and Information Systems, Irwin-Dorsey, 1973.

Martin, J., Design of Real-Time Computer Systems, Prentice-Hall, Incorporated, 1967.

Martin, J., Systems Analysis for Data Transmission, Prentice-Hall, Incorporated, 1972.

Martin, J., Teleprocessing Network Organization, Prentice-Hall, Incorporated, 1970.

McManis, R. B., Computerized Management Tools for Use in the Analysis of AUTODIN Automatic Switching Centers and Associated Tributaries, M.S. Thesis, Naval Postgraduate School, Monterey, California, 1973.

Naval Command Systems Support Activity Document Number 84C012A FD-01, Automation of CNO Communications Center Functional Description, March 1971.

Naval Command Systems Support Activity Document Number 84C012A OM-01 Volume I and II, Automation of CNO Communications Center Computer Operation Manual, July 1973.

Naval Command Systems Support Activity Document Number 84C012A SS-01, Automation of CNO Communications Center System Description, June 1973.

Naval Command Systems Support Activity Document Number 84C037 FD-01, Automation of NAVCOMMSTA Norfolk Functional Description, April 1972.

Naval Command Systems Support Activity Document Number 84C037A SS-01 Volumes I, II and III, Naval Communications Processing and Routing System (NAVCOMPARS) System/Subsystem Specification, January 1974.

Naval Command Systems Support Activity Document Number 84C041 FD-01, Automation of NAVCOMMSTA Guam Functional Description, February 1974.

Naval Command Systems Support Activity Document Number 84C041 PT-01, Naval Communications Processing and Routing System (NAVCOMPARS) Test and Implementation Plan (Draft), September 1973.

Naval Command Systems Support Activity Document Number 84C042 FD-01, Automation of NAVCOMMSTA Honolulu Functional Description (Draft), August 1973.

Naval Command Systems Support Activity Document Number 84C043 FD-01, Automation of NAVCOMMSTA Italy Functional Description (Draft), February 1974.

Naval Command Systems Support Activity Document Number 84C047 TN-01, Remote Information Exchange Terminal (RIXT) Technical Note, August 1973.

Naval Command Systems Support Activity Document Number 84C051 TN-01, Automation of Crystal Plaza Telecommunications Center Technical Note, February 1973.

Naval Command Systems Support Activity Document Number 84C057 TN-03, ADP System Specification for a Message Exchange Center Technical Note (Draft), December 1973.

Naval Command Systems Support Activity Document Number 84C070A TN-01, LDMX/NAVCOMPARS Conversion Feasibility Study Technical Note, January 1974.

Naval Telecommunications Command, Naval Communications Automation Plan (U) Subsystem Project Plan (SPP), May 1972.

Pelton, R. L., Evaluating Naval Communications, M.S. Thesis, Naval Postgraduate School, Monterey, California, 1973.

Price, J. D., The Local Digital Message Exchange: A Description and Analysis, M.S. Thesis, Naval Postgraduate School, Monterey, California, 1973.

Schriber, T. J., Preliminary Printing of A GPSS Primer, The University of Michigan, 1972.

DISTRIBUTION LIST

1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 2012 Naval Postgraduate School Monterey, CA. 93940	2
3.	Professor Sam H. Parry Code 55Py Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, CA. 93940	1
4.	Professor N. F. Schneidewind Code 55Ss Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, CA. 93940	1
5.	Commander Eugene J. Normand Code 52No Naval Postgraduate School Monterey, CA. 93940	1
6.	Chairman, Department of Operations Research and Administrative Sciences, Code 55 Naval Postgraduate School Monterey, CA. 93940	1
7.	Commander Naval Telecommunications Command 4401 Mass. Ave Washington D.C. 20390	1
8.	LCDR Wm. R. Lawrence, 1110/170-34-4854, USN 23 Fairview Road Paoli, PA. 19301	1
9.	LCDR M. D. Barker U.S. Naval Communications Station Box 582 Fleet Post Office New York, N. Y. 09544	1
10.	Naval Command Systems Support Activity 2733 Bg. 196 Washington Navy Yard Washington D. C. Attn: Mr. John Springett	1
11.	Commanding Officer, U.S. Naval Communication Station, Norfolk Fleet Post Office New York, N.Y. 09544	1

12. Commanding Officer, U.S. Naval Communication Station 1
Italy
Fleet Post Office
New York, N.Y. 09544

13. Commanding Officer, U.S. Naval Communication Station 1
Honolulu
Fleet Post Office
San Francisco, CA. 96601

14. Commanding Officer, U.S. Naval Communication Station 1
Guam
Fleet Post Office
San Francisco, CA. 96601

15. Commander, Naval Telecommunications Command 1
4401 Massachusetts Ave., N.W.
Washington, D. C. 20390

Thesis
B223 Barker 154944
c.1
The Naval Communications Processing and Routing System: a model for management.